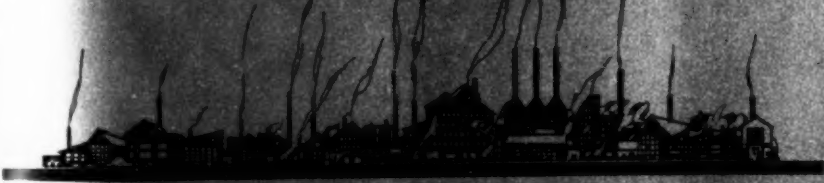
Vol. XII No. 4

The CHEMIST

APRIL • 1935

Publication of The AMERICAN INSTITUTE of CHEMISTS

TERCENTENARY ANNIVERSARY OF THE AMERICAN CHEMICAL INDUSTRY



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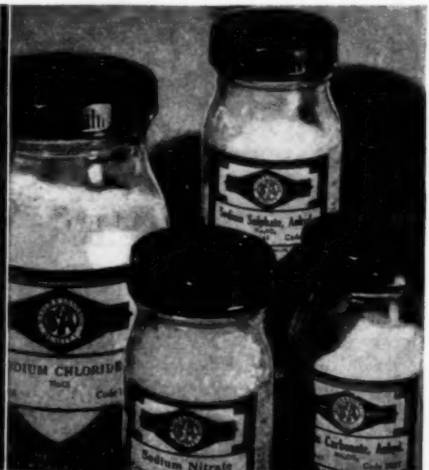

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The CHEMIST

Publication of

The American Institute of Chemists, Inc.

Alan Porter Lee, F.A.I.C., *Editor*, 233 Broadway, New York City
V. F. Kimball, *Assistant to the Editor*

Volume XII | APRIL, 1935 | Number 4

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Entered as second-class matter February 28, 1930, at the Post Office at Easton, Pa., under act of August 24, 1912.

Issued monthly except in June, July and August at 20th and Northampton Sts., Easton, Pa. Subscription price, $2.00 a year. Single copy, 25 cents.

Program of the New York Meeting of the American Chemical Society

April 22 to 26, 1935

General Program

SATURDAY, APRIL 20

1:00 to 5:00 P. M.—Registration for members of New York and North Jersey Sections, Hotel Pennsylvania.

SUNDAY, APRIL 21

4:00 to 8:30 P. M.—Registration, Mezzanine, Hotel Pennsylvania.

MONDAY, APRIL 22

8:30 A. M. to 8:30 P. M.—Registration, Hotel Pennsylvania and Hotel New Yorker.

9:00 A. M.—Divisional Meetings, convention hotels. Plant Inspection Trips.

12:15 P. M.—Group Luncheons.

2:00 P. M.—Divisional Meetings. Plant Inspection Trips.

6:15 P. M.—Group Dinners.

EVENING—Open for individual engagements.

TUESDAY, APRIL 23

8:00 A. M.—Group Breakfasts.

8:30 A. M. to 8:30 P. M.—Registration.

9:00 A. M.—Divisional Meetings, continued. Plant Inspection Trips.

12:15 P. M.—Group Luncheons.

2:00 P. M.—Divisional Meetings. Plant Inspection Trips.

7:00 P. M.—Nichols Medal Dinner and Meeting. Grand Ballroom, Hotel Pennsylvania. A. W. HIXSON, *Presiding*. Open to all members of the American Chemical Society and their guests. Limited to 1,300. Program:

Reverend Eugene P. Burke, C.S.C., University of Notre Dame, **"The Personal Side of Dr. Nieuwland's Life."**

E. R. Bridgwater, E. I. du Pont de Nemours and Co., **"Practical Applications of Dr. Nieuwland's Work."**

Presentation of the Medal by **J. M. Weiss,** chairman, Nichols Medal Jury of Award.

J. A. Nieuwland, Medalist, **"Basic Research on Unsaturated Hydrocarbons."**

10:00 P. M.—Dance, Roof Garden, Hotel Pennsylvania. Open to registrants of the convention and guests of Nichols Medal Dinner.

WEDNESDAY, APRIL 24

8:00 A. M.—Group Breakfasts.

8:30 A. M. to 8:30 P. M.—Registration, Hotel Pennsylvania only.

9:30 A. M.—Council Meeting, Salle Moderne, Hotel Pennsylvania. Plant Visits except for Councilors.

12:15 P. M.—Group Luncheons.

2:00 P. M.—General Meeting. **Chemical Industries Symposium.** Grand Ballroom, Hotel Pennsylvania.

Roger Adams, President, American Chemical Society, **Introductory Address.**

Alfred H. White, University of Michigan, **"The Scientific Foundations of the American Chemical Industries."**

Lammot du Pont, president, E. I. du Pont de Nemours and Co., **"Human Wants and the Chemical Industries."**

William B. Bell, chairman of the board, American Cyanamid and Chemical

Corp., **"Recovery—by Alchemy or Chemistry?"**

Thomas Midgley, Jr., vice-president, Ethyl Gasoline Corp., **"The Rôle of Chemistry in the Next Hundred Years."**

6:00 P. M.—Reception, Jade and Basildon Rooms and Silver Corridor, Hotel Waldorf-Astoria.

7:00 P. M.—Convention Banquet. Grand Ballroom, Waldorf-Astoria. Open to registrants and their guests. Speakers are the **Honorable Francis P. Garvan,** president of the Chemical Foundation, Inc., who will serve as toastmaster; the **Honorable Pat Harrison,** United States Senator from Mississippi; and the **Honorable James W. Wadsworth,** Representative from New York. **Miss Helen Jepson,** soprano, of the Metropolitan Opera Co., will sing. The Eli Lilly and Company Award of $1000.00 and Medal will be presented to **Willard M. Allen,** by **President Roger Adams,** for research in biological chemistry. Formal dress will not be obligatory.

10:15 P. M.—Tercentenary Ball. Grand Ballroom, Hotel Waldorf-Astoria, immediately after the banquet. Open to all members and guests who attend the banquet.

THURSDAY, APRIL 25

7:30 A. M.—Group Breakfasts.

8:30 A. M.—Registration, Hotel Pennsylvania.

9:00 A. M.—Divisional Meetings. Plant Inspection Trips.

12:15 P. M.—Group Luncheons.

2:00 P. M.—Divisional Meetings. Plant Inspection Trips.

6:00 P. M.—Group Dinners.

8:30 P. M.—Complimentary Theatre Party, "The Great Waltz." Center Theatre, Radio City. Admission limited to regularly registered members and guests. Admission only by ticket issued at time of registration.

FRIDAY, APRIL 26

7:30 A. M.—Group Breakfasts.

9:00 A. M.—Divisional Meetings. Plant Inspection Trips.

12:15 P. M.—Group Luncheons.

2:00 P. M.—Divisional Meetings. Plant Inspection Trips.

EVENING—Open for individual engagements.

SATURDAY, APRIL 27

Plant Inspection Trips.
Special all-day trips.

LADIES' PROGRAM

MONDAY, APRIL 22

4:00 P. M.—Reception at River Club, 56th St. and East River. MRS. FRANCIS P. GARVAN, *Hostess*.

Special busses leave Hotel Pennsylvania at 3:30 P. M.

EVENING—Open for theater parties of individual members.

TUESDAY, APRIL 23

9:30 A. M.—Visits to Long Island Estates. Special busses leave Hotel Pennsylvania at 9:30 A. M. for visits to estates near Glen Cove, L. I. (gardens and residences) with luncheon at Piping Rock and Creek Country Club and afternoon tea as guests of Mrs. Francis P. Garvan.

7:00 P. M.—Nichols Medal Dinner and Meeting. Grand Ballroom, Hotel Pennsylvania.

10:00 P. M.—Dance, Roof Garden, Hotel Pennsylvania.

WEDNESDAY, APRIL 24

MORNING—View of New York from the Observation Tower of the Empire State Building, and Reception by Hon. ALFRED E. SMITH. Time to be announced by Information Committee in convention hotels.

2:00 P. M.—Fashion Show by Franklin Simon and Co.; and Beauty Talk by Mme. Élène of Vienna and the House of Pine, New York, at Starlight Roof Garden, Hotel Waldorf-Astoria.

6:00 P. M.—Reception, Hotel Waldorf-Astoria.

7:00 P. M.—Convention Banquet. Grand Ballroom, Hotel Waldorf-Astoria.

10:15 P. M.—Tercentenary Ball. Grand Ballroom, Hotel Waldorf-Astoria. Will follow immediately after the banquet. Open to all members and guests who attend the banquet.

THURSDAY, APRIL 25

9:00 A. M.—Bus Tour of the city, 3½ hours. Busses leave the Hotel Pennsylvania.

2:00 P. M.—Bridge and Tea, Starlight Roof Garden, Hotel Waldorf-Astoria. Preceded by "Newest Features and Developments in the Bridge Game," by Mrs. Estelle H. Brinsmade, bridge expert.

8:00 P. M.—Complimentary Theater Party, Center Theatre, Radio City, "The Great Waltz."

FRIDAY, APRIL 26

Optional activities.

A. I. C. Luncheon

A luncheon of The American Institute of Chemists will be held at 1:00 o'clock April 25th, at the Hotel Martinique, New York City, following the 11:00 A. M. meeting of the American Chemical Society devoted to a discussion of unemployment and the professional status of chemists. Members of the Institute who are also members of the American Chemical Society are urged to attend the earlier meeting in the Chelsea Room of the nearby Hotel Governor Clinton to hear the reading and discussion of the report of the Unemployment Committee.

Members are urged to bring non-members who are interested in the welfare of chemists to this luncheon. Please make reservations now with The American Institute of Chemists, 233 Broadway, New York City.

For Women Chemists

For the first time in the history of the American Chemical Society, the women members will have their own headquarters, at the Hotel Pennsylvania, during the 89th meeting of the A. C. S. They have planned a luncheon at Schraffts, 220 West 57th Street, New York City, on Wednesday, April 24th, at which Dr. Glenola Rose, Chairman of the Women's Service Committee of the A. C. S., will preside and Dr. Lillian M. Gilbreth will be the guest of honor. Arrangements for the headquarters and the luncheon have been made by Calm M. Hoke, F.A.I.C. Members of the local committee are: Cornelia T. Snell, *Chairman;* Marie Farnsworth, Dorothea Hass, Calm M. Hoke, F.A.I.C., Elizabeth Pickering, Clara Schmidt, Florence E. Wall, F.A.I.C., and Lois W. Woodford.

American Chemical Society Meeting

San Francisco, August, 1935

Special arrangements have been made by THE CHEMIST with the Dollar Steamship Line whereby a party of fourteen or more attending the San Francisco convention of the American Chemical Society will receive a special discount below the regular fares. This will undoubtedly prove of interest to members of The American Institute of Chemists and the American Chemical Society, and others who are desirous of attending this convention.

It is suggested that inquiries for information be made to the THE CHEMIST as early as possible in order that the best accommodations may be obtained.

To Institute Members and Friends

We are glad to call attention to a number of manufacturers who are using our advertising pages in this issue for the first time, in addition to those firms who have been advertising with us for many years. This is the first time any serious effort has been made to explain our advertising advantages to executives who have the responsibility of buying space. The result of recent efforts has been gratifying and the increased advertising revenue is largely responsible for the greater size and usefulness of the current issue.

(*Please turn to page 125*)

EDITORIAL

IN this kaleidoscopic age in which scientific discoveries crowd upon each other's heels in their mad rush for advancement, and in which there is a constant change in the forms appearing upon the frosted glass of life, the human mind is unable to measure the distances between the events of today and those which are recorded upon the books of the past. Distances and times become so intermingled and blurred that they appear as faintly undefinable forms without definite limitations or boundaries.

As History writes, she fails to record many events of little moment at the time but which are of the greatest importance in the years to come.

It is as difficult to place one's finger upon the first cause of a series of events extending over the centuries as it is to determine the origin of the life force within the tiny seed we plant.

No thing is the result of spontaneous, unassisted origin. All things are the products of events extending far beyond the conception of man.

Hence, the impossibility of definitely stating that at this point a thing began and that it has no previous existence.

This is particularly true with regard to a science based, as it is, upon the accumulated knowledge of the past and ramifying, as it does, the facts of nature and the imagination of man.

It is well, however, to place a date of origin, faulty though it may be, in order that there may be a point from which to measure the events which follow.

Some one, whose name has not as yet been recorded in history, has determined, or perhaps one should better say has decided, that the chemical industry in America has its origin in the colony of Connecticut in 1635 when the later Colonial Governor, John Winthrop, took the first steps to remove chemistry from the blacksmith shop and the yard of the country farm house and place it upon the more stable basis of a chemical industry.

This date will do as well as any other for the purpose of a celebration and for any other reason that seems conceivable.

It is well to refresh our memories with the importance of three hundred years in the history of the United States.

1635 is nearer by more than a century and a half to the day when Columbus first set foot upon the American Continent than it is to the day upon which this is written.

It is but fifteen years after the landing of the Pilgrim Fathers, five years after Boston received its illustrious name, and when the State of Virginia extended to the Pacific Ocean.

There were but a few small settlements along the Atlantic Coast line; the colonies were being slowly formed, and the English settlers in Jamestown were as far removed from the Dutch in Connecticut as Cape Horn is distant from the City of Washington today.

Beyond this narrow eastern strip of land there extended an unknown and undiscovered world of wilderness and prairie that had to await the years for the white man.

It is not known exactly what Governor Winthrop did to found an American chemical industry except that he issued a statement that it would be a good thing to have one, and it surely was an uninviting soil in which to plant the seed.

History is silent for a century or more about this new chemical industry, and, perhaps, it is well that this is so, for one can well imagine that its growth was slow and its discouragements many.

In 1635 there was not a college or university in America; Elihu Yale was 13 years of age, and Harvard was not founded until the following year.

The settlers were surrounded by Nature's richest gifts, but evidently the universities did not recognize the necessity of supplying these settlers with improved products for their physical needs, as the curricula indicate that the universities' efforts were expended in teaching these sore-beset settlers the mysteries of the Greek and Latin languages and the philosophies of those ancient people.

And thus years and the centuries ran their courses. The industry moved forward slowly because of its failures, until the germ of an idea occurred to the industry but not to the universities.

The industry finally conceived the idea that progress should not be based upon the results of failures, the causes of which were unknown, but should be predicated upon a knowledge of the elements of success, but here a seemingly unsurmountable obstacle presented itself.

The manufacturers had little or no knowledge of chemistry and it was evident that such information was absolutely necessary if the underlying reactions of success were to be determined.

Thus arose the first demand for chemists; a demand which could be satisfied by the universities only; a demand which was so insistent that the universities were compelled to introduce chemistry into their courses of study.

This training of chemists was slow work. There was nothing aes-

thetic about test tubes and crucibles. A knowledge of chemical reactions was not a basis for parlor conversation, and the poor chemist found himself at a disadvantage in a discussion upon Greek theology or Roman laws. A chemist was placed in the same category as a butcher or a laborer—and he still is, in some of the Civil Service classifications.

It took many years to teach "society" that a chemist may have the attributes of a gentleman, and still more years to teach it that a chemist may be a lady.

It was natural that America should be considerably behind the European nations in its scientific knowledge, for the necessity of wresting a habitation and a living from unwilling nature and of protecting life and property from the savage tribes occupied the time and thoughts of these first settlers; but this new idea of the value of a chemist caused a thirst for scientific knowledge that could not be assuaged and which has increased with the passing years.

The birth of this first American chemist is the birth of the American chemical industry, for without the chemist there could not be, and there cannot be, the science of chemistry.

It was thought then, as it is frequently believed now, that the advancement of the chemical industry was dependent wholly upon the efficiency of the business organization; that the financiers with their careful accountings, that the workmen in the factories with their sweaty faces and the salesmen with their circus vocabularies were the foundations upon which a successful chemical industry could be erected.

In this mad rush for financial supremacy—the one manufacturer against the other—the chemist, toiling over his laboratory bench and pouring the real life blood into the industry, was forgotten.

Thus each unit of chemical production fought alone, still imbued with the old Indian fighting instinct, asking for no assistance from others and giving none.

In spite of this lack of cooperation the industry grew. It fed upon the requirements of the rapidly increasing population and the patriotic idea of consuming home products rather than those of foreign nations, which had attempted to destroy the freedom and liberty of the people.

There came a time, however, when the results of this isolation and self-destruction within the industry itself became greater than the demands for its products from without, and it was evident that some method should be devised whereby the units of the industry could be brought into closer and more constructive relation to each other.

Two hundred and more years of suspicion could not be allayed except by some concerted action between a number of the more influential

members of the industry; and a few of them, recognizing the injury that had arisen because of personal animosities, conferred with each other and formed The American Chemical Society.

It is not stating too much to aver that the formation of this Society was the turning point in the success of the American chemical industry.

Interesting itself, as it has from its origin, in the science of chemistry, in encouraging chemical research, and in impressing upon the manufacturers the necessity of combining science with production, it can be properly credited as having been, and of still being, the motive force which has brought the American chemical industry to its present most important position in the industry throughout the world.

And still the chemist toiled over his laboratory bench, pouring the real life blood into the industry—and still forgotten.

It was not until a few years ago that there arose in the minds of some of those most interested the thought that this great industry was based almost entirely upon the chemists as human beings; that they had overlooked the fact that they had not recognized the seed from which these great things had sprung; that they had planted that seed too sparsely and had neglected it after it had been planted.

Then again some of those most interested in the industry conferred and formed a second organization to supplement and assist the older American Chemical Society in a mutual endeavor to advance the industry.

Thus The American Institute of Chemists was organized to strengthen the American chemical industry by strengthening its very foundation—the chemist.

If it is admitted, as it must be, that the chemical industry is dependent upon the results of the chemist, it must be admitted with equal force that the industry must protect and encourage the chemist.

The laboratory must no longer be considered as simply a storehouse for chemical apparatus, but must be recognized as the abode of a human being, the chemist.

The American Institute of Chemists is awakening the industry to a correct appreciation of the properly qualified chemist and to the importance of his place in the industry, in order that by encouragement and cooperation the industry may be provided with the necessary equipment for scientific and commercial success.

The American chemical industry may have been founded in 1635, but its permanent foundations were laid when the first chemist entered its laboratory.

H. S. N.

The Chemist in Relation to His Profession

By M. L. Crossley, F.A.I.C.

THE problems of a profession concern every member of the profession. Their solution requires solidarity of action. This united action calls for unselfish individual service. The good of the group is of greater importance than that of the individual.

To provide the means for professional solidarity and unity of purpose by the chemist, The American Institute of Chemists was founded about thirteen years ago. It aimed to secure the greatest possible cooperation in the task of placing the standards of the chemical profession on the summit occupied by the other learned professions. It saw the chemist as a person who not only is qualified to ascertain the facts of chemistry but who also is capable of interpreting these facts so as to benefit humanity and accelerate progress. This requirement is basic to the advancement of the chemical profession in this country. To secure it, a definite basic training is essential. This training should embrace an education broad enough to insure competent service and wise leadership. Competency and character are essential to public confidence in the integrity of a profession. To hold this public confidence the principles of the professional conduct must be maintained at a high level and the standard of proficiency of the average must be good. Professional conduct, like general conduct, is governed by the ideals and aims of the individual. To have a high standard of group conduct, it is essential that the group be composed of individuals of high ethical principles. To insure a high standard of service by the chemical profession, an efficient method of selection must be employed. This selection must begin with the process of education. The teacher of chemistry must accept the major share of the responsibility for the type of men who profess to be able to serve in chemistry and the kind of service they render.

The services required of a chemist involve a wide range of activities and responsibilities. The professional standards must be elastic enough to embrace all types of chemical service. The basic training must be sound enough to permit of future specialization. Unless it is adequate, the person should not be allowed to represent himself as a chemist, because if he is incompetent, both he and the profession suffer. The profession must see that only those who are adequately trained and who have good character are allowed to seek and hold positions as chemists. This is basic to the maintenance of a high professional status of chemists.

The objectives to be attained by the profession of chemistry as formulated by The American Institute of Chemists—the organization concerned with the professional status of chemists—in Article I of its constitution, are to:

1. Provide and enforce a code of principles of professional conduct which merits public esteem and justifies confidence in the integrity of the chemist.
2. Establish and maintain a standard of proficiency of such excellence as to insure competent and efficient service.
3. Secure an adequate basic training for the profession, and admit to fellowship in The Institute only those of proved education, experience, competency, and character.
4. Strive to enhance the prestige and distinction of the profession so as to extend its influence and usefulness.
5. Establish and maintain a register of its membership in which there will be a complete record of the training, experience, and fitness for service of each individual member.
6. Seek to improve the economic status of the profession by cooperating with employers to secure a satisfactory appreciation and evaluation of the services of the chemist.
7. Provide a means for the appropriate recognition of distinguished service to the profession.
8. Cooperate with all the agencies serving chemistry to make the profession of chemistry a powerful factor in the advancement of intellectual and material progress in the United States of America, to the end that this nation shall assume its rightful place as a leader among the nations of the world in scientific thought and accomplishment.
9. Lend support to the work of the chemical societies in the education of the public to a better appreciation of the contribution of the chemist to world progress; and,
10. Render such other services to the profession as developments shall warrant and The American Institute of Chemists shall approve.

The foundation has been built for the realization by the profession of all of these objects. Progress is slow but sure. All that is needed to accelerate the progress of The American Institute of Chemists is the support of all who are qualified for the profession. If the practice of chemistry is a profession, then, it should be organized to render excellent service. The organization is provided in The American Institute of Chemists, which, working in harmony with the chemical societies, whose function it is to foster the science of chemistry, will uphold the standards and dignity of the profession of chemistry. The solidarity needed to make this profession great cannot be nurtured on indifference to the necessities of the profession, by chemists who should be capable of appreciating the significances of the problems that confront the chemist as a professional man. The time has come for all to unite in the

effort to make this profession strong and useful. There is no excuse for the existence of The American Institute of Chemists or any similar organization unless it is representative of the entire profession. It is so only when the majority of those eligible are members and are actively promoting the aims of the profession. The future of the profession depends upon how the problems that now face it are solved; their solution demands the attention and help of the entire profession.

The American Institute of Chemists has accomplished much with its meager resources. It could do more with adequate support. It established a code of professional conduct and has maintained it within the limits of its knowledge and ability. As basic to the establishment of a high status of the profession, a survey of the education of the chemist was made and minimum requirements were established for the broad fundamental education of all chemists. This report was sent to all institutions of learning in this country. It has influenced the course given in certain institutions but it has not been so effective in influencing the education of chemists as it would have been had all the qualified chemists of this country been members of the Institute. The most serious problem before the profession is still that of adequate education of the right people for the profession. It is not enough to pour out chemical information into the troughs of learning for all who may try a taste of it. The good of the profession demands that we select those who are best fitted to serve in chemistry and then see that they are adequately trained.

Again, The Institute has influenced the economic status of the profession in several instances, but its work has been mainly preparatory to greater accomplishments. It has succeeded in certain instances in securing greater compensation for chemists and proper recognition of the dignity of the profession. Its study of the economic basis for the amortization of the service investment of the chemist is progressing and it is hoped that a definite plan will be evolved and proved feasible.

The problems of licensing chemists by different States are becoming more and more acute. As the responsibilities of chemists become more varied and expert judgment must be rendered, there arises the necessity for some fixed authority to pass upon the expertness of those who would qualify for service. The Institute cannot pass on those outside its membership. If there are to be State regulations The Institute must see that they are consistent with the best interests of both the profession and the public served.

The biggest problem for the profession to solve is that of employment

(*Please turn to page 118*)

The Contribution of the Chemist to the Sugar Industry for the Advancement of Modern Civilization

By C. A. Browne

U. S. Department of Agriculture

EVERY important invention and industrial discovery has had an influence in improving the social welfare of certain communities of mankind, although for a time at least these benefits may seem to have been offset by corresponding ill-effects among other portions of the human race. This has been particularly the case with applied chemistry where the creation of methods for producing a new commodity has often brought prosperity to one region and temporary depression to another, in which an old competing activity was either forced out of existence or compelled to undergo a trying period of readjustment. In the long run the benefits of new inventions in contributing to the material welfare of the localities where they have been introduced outweigh the temporary discomforts that result from breaks in long established usage. One purpose of the present paper is to cite a few illustrations of this general law of progress in the case of chemists who at various times in the past few centuries have helped to revolutionize the art of producing sugar.

The sugar that was used in Europe and Colonial America two centuries ago was the sugar made by slave labor upon tropical plantations. The methods of cultivation and manufacture were exceedingly primitive and laborious, having remained practically unchanged for over a thousand years. In medieval times sugar was an expensive commodity which could only be afforded by the most wealthy. The enormous expansion of the cane sugar industry in the tropics of the New World during the sixteenth, seventeenth, and eighteenth centuries was one of the great factors which reduced sugar from a luxury to a common kitchen necessity. The phenomenal growth of the cane-sugar industry in this period was made possible, however, only by the wide extension of slave labor, partly from aboriginal Indians, but more generally from Negroes first introduced by the African slave trade. The inhuman treatment of the slaves on tropical sugar plantations excited at a very early stage the attention of philanthropists who sought to improve conditions by laws forbidding the traffic in human beings and by a popular appeal to abstain from the use of slave-made sugar—a campaign known as the

"antisaccharite movement." The injuries encountered by slaves from the loss of a hand or arm in the grinding machinery of cane mills or from being scalded by the steam of open evaporating kettles led chemists and other inventors to devise improvements in manufacture, some of which were of value in making the work less arduous and dangerous.

The great movement which led to the reform of the tropical sugar industry did not come, however, until the early nineteenth century when the importation of colonial sugar into Europe during the Napoleonic wars was interrupted by the Continental Blockage. A sugar famine arose in Europe which obliged chemists to turn their immediate attention to the urgent problem of providing a substitute for tropical sugar. The heroic efforts which resulted from this necessity led to the establishment of three entirely new sugar industries—that of grape sugar due largely to the work of Proust and Parmentier; that of starch sugar, or glucose, due to Kirchof; and that of beet-sugar due to Achard. The first two of these new developments were not of immediate significance. The establishment of the beet sugar industry, however, was most prompt in its effects and of vast influence in improving the social and economic welfare of mankind during the nineteenth century.

In 1747 the German chemist, Margraf, isolated for the first time crystalline sucrose from the beet. His laboratory experiments were followed up some fifty years later by Achard, who in 1800 built at Kunern in Silesia the first factory for making beet sugar on a commercial scale. Under the stimulus of the blockade and the powerful patronage of Napoleon the new industry was soon established on a prosperous basis. After the downfall of Napoleon and the abolition of the blockade, French statesmen were farsighted enough to protect their new domestic sugar industry by bounties and duties. These incentives and the new improvements introduced by European chemists soon placed the beet sugar industry ahead of its tropical rival in point of efficiency. By its rôle as a valuable rotation crop, by producing useful by-products (molasses, pulp, etc.), by increasing the lowered income of farmers and by furnishing new opportunities for employment, the introduction of the sugar beet has been regarded by many writers as one of the greatest contributions to the welfare of the human race. Both the sugar beet and the beet-sugar industry are children of chemistry and they have added in almost countless ways to the social and economic improvement of every community where they have been introduced. The world is indebted to Margraf, Achard, Chaptal, Fremy, Payen, Vauquelin, Dubrunfaut, and scores of other chemists who might be named for this great agricultural and industrial contribution by which the lives of

millions of people have been made more comfortable and happier.

In order to maintain itself against the competition of beet sugar in European markets, the tropical cane sugar industry was obliged to adopt many improvements from its competitor. The vacuum pan, centrifugal, filter press, polariscope, use of bone black, and improvements in clarification and evaporation were first developed by the beet sugar industry of Europe before they were adopted by the cane sugar industry of the tropics. These new improvements effected not only a great saving in costs of manufacture but they reduced considerably the hazards and discomforts of the early primitive methods.

The greatest of the new technological improvements in sugar production was developed, however, not by an European but by a native American, Norbert Rillieux, of New Orleans, upon a Louisiana cane sugar plantation. This was multiple effect evaporation—an epoch-making invention which by its saving in costs of evaporation and by reducing the discomforts of sugar factory employees, who had previously been obliged to work in the hot steam-laden atmosphere of open-kettle sugar houses, was soon introduced in every country of the world. It is worthy of note that in 1934 thirty-eight sugar industrial organizations of the world, under the commendable initiative of Messrs. H. C. Prinsen-Geerligs and Edward Koppeschaar of Holland, in grateful recognition of their indebtedness to Rillieux, placed a beautiful bronze memorial in the old Cabildo building of New Orleans to celebrate the one hundredth anniversary of his invention.

The cane sugar industry has been threatened with ruin on several occasions by the advent of cane diseases (root rot, mosaic, etc.). The salvation of tropical America from an impending disaster of this kind was due largely to the early work of the late Sir John B. Harrison, Government chemist for many years in the British West Indies, and his associate, John R. Bovell, in breeding new disease-resistant sugar-cane varieties of high sugar content. The discovery by Harrison and Bovell, in 1888, that the seed of the sugar cane, which had hitherto been regarded as sterile, could be made to germinate, came at a most opportune time, for just after this date the old Bourbon variety of cane, which for centuries had been the chief source of the world's sugar supply, began to succumb to the attack of a fungus disease. The yield of cane diminished enormously and the sugar industry of the West India Islands would have been ruined had the new hardier seedling canes, developed by Harrison and Bovell, not come to the rescue. The economic and social welfare of millions of people was saved by means of this discovery.

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The Contribution of the Chemist to the Petroleum Industry for the Advancement of Modern Civilization

By Benjamin T. Brooks, F.A.I.C.

Consultant

BEFORE the first petroleum refinery in America was built, Professor Benjamin Silliman of Yale University examined a sample of crude petroleum from Pennsylvania and suggested the refining of the distillate fractions by sulphuric acid and pointed out the suitability of certain fractions for use as illuminating oil, the heavier fractions as lubricants and the wax, already known from shale oil, as candle stock.

Until about 1910, chemists and chemical engineers played a rather modest and subordinate part in the industry. In the intervening years outstanding chemical improvements were rare, Frasch's successful treatment of the malodorous sulphur-bearing oil of Ohio and the manufacture of asphalts by air-blowing residuums being exceptional.

Today the Petroleum Division of the American Chemical Society is the second largest Division of this Society, and the number of other technical men, geologists, mechanical engineers, metallurgists, etc., has increased proportionately. Salaries of chemists in the industry have risen with the importance of their functions and service in the industry. In 1912 came the beginning of commercially successful cracking processes. Nearly all of the names conspicuous in this great development are the names of chemists, or men trained in chemistry, such as Burton, Roy and Walter Cross, Egloff, Ellis, Holmes, Wagner, and many others. A fair number have risen to occupy high executive positions in the industry. President Irish began his work in a sulphuric acid plant, Henry L. Doherty in making artificial gas, and more recently R. E. Wilson, G. H. Taber, Jr., and R. T. Haslam may be added to this number. So, as long as the traditions of democracy and liberty prevail in American industry, chemists may expect their share of such positions of executive leadership.

With the rapidly increasing number and variety of technical problems confronting the industry it is safe to predict that the number of chemists and engineers employed by the industry will continue to increase. His earnings may be expected to advance as the importance of his work increases. The writer has no sympathy with suggestions of organizing chemists, or other scientific men, along lines akin to labor unions, or of seeking to boost his earnings by unduly emphasizing the importance of

his work. Men of ability are still rare enough to be earnestly sought out.

With the increasing attention being given to petroleum as a chemical raw material, more and more painstaking investigation must be done. This calls at once for good judgment in the direction of work, management of a staff of workers, and careful selection of problems for attack, and such directors will naturally be well paid, but such work also calls for a very large proportion of men who are willing and capable of doing painstaking investigation. In general such work has never been paid very well and probably never will, but out of it come the experienced directors and the greater rewards of achievement to those who can qualify for them. The satisfactions of doing scientific work ensures that there will always be a plentiful supply of such men. As an unknown writer of an earlier day wrote as a foreword in Johann Christien Becher's *Acta Chymici Monacensis, seu Physica Subterranea* (1669), "The chymists are a strange class of mortals impelled by an almost insane impulse to seek their pleasure among smoke and vapour, soot and flame, poisons and poverty, yet among all these evils I seem to live so sweetly that may I die if I would change places with the Persian King." If one's ambition is to be a Persian King or a Postmaster General, he should eschew chemistry.

The Chemist's Relation to His Profession

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and relief. The Institute has done a little but it must do more. It is imperative that a bureau of appointments be organized and maintained efficiently. This must do more than place the men who are out of work; it must see that the man qualified to render the best service is always available for the work. It must have complete information of the potential work to be done and use its influence to bring the right man to the right job. Such a bureau would also keep active records of possible positions for chemists and show that it is good economics to fill them with adequately trained men, instead of cheap, untrained laboratorians.

In The American Institute of Chemists is the means of establishing the importance of the profession of chemistry in the social growth and economic development of this country. Through the medium of its publication, THE CHEMIST, the profession will become better known and appreciated. The opportunity is offered for united service in advancing the status of the profession to the heights of prestige and distinction which it deserves. It is not the work of a few that will count in the struggle to reach this goal, but the combined efforts of all chemists. The profession needs us all; now.

The Contribution of the Chemist to Agriculture for the Advancement of Modern Civilization

By Horace G. Byers, F.A.I.C.

Chief, Soil Chemistry Division, Department of Agriculture

IT is frequently impossible to detect the primary influence which culminates in magnificent achievements. Even when it appears possible it is found that to the original influence have been added contributions of independent source and diverse origin. It is not possible justly to apportion individual credit. This is particularly true of agricultural chemists and of the results of their constructive efforts in the interest of the general welfare. Hence few names will appear in what follows.

In the past three centuries the whole picture of rural life in America has altered. The change has been particularly rapid in the last fifty years and the end is not yet. Time was, and not so long since, when the farm was largely a self-contained economic unit. The condition is most fully exemplified by the Southern plantation. The plantation not only produced all the food it consumed, but it also carried on nearly all essential manufacturing processes. It even produced its own motive power and its own labor. To a degree every farm was in the same condition. The farmer supplied all the needs of his own family and sold only the surplus. He needed, and usually had, but little money. If the surplus was large it was used for luxuries and higher education.

Today the situation is drastically different. The farmer has become the producer of commercial raw material and usually of but one, or at most of a few types. He must produce a large excess above the needs of his own family in order to purchase the necessities he lacks. He no longer makes his own shoes or fashions his own clothes. He no longer bakes his own bread, makes his own butter, or his own whiskey. Even the community mill is gone. Instead of being an economic asset, a large family is, as elsewhere, a liability. Even his own motive power is not of home production but is bought in tins or tanks. He, like the urban dweller, no longer adapts his diet to the season but depends upon cold storage and refrigeration for fresh fruits and vegetables. He has turned over his food preservation to canner and packer. He has become a specialist. He has large and increasing need for money not alone for

food and clothing but for the purchase of machinery to equip and run his plant. That all these and other changes which have occurred are improvements is perhaps debatable. That they present tremendous problems is not.

It is not the present purpose to discuss the influence which have produced the type of changes mentioned although to many of them agricultural chemists have made important contribution. Among the many causes of change are improvements in transportation by train, truck, automobile, and airplane; the development of surfaced roads; the development of refrigeration; the centralization of manufacturing processes for meat, butter, and canning; very important has been the spread of education. Whatever the causes have been one of the results is that, wittingly or unwittingly, the activities of agricultural chemists in the interest of social welfare have been directed mainly along two general lines. These are: Efforts to increase the per capita output of the farmer and to protect the public against exploitation and fraud. It is not implied that efforts along these lines have been confined to chemists only. Other scientists have done their bit and social workers, politicians, and economists have taken part in the problems. The contributions of the agricultural chemists have been of no small importance. Whether these efforts have been or will be crowned with full success is another debatable question.

Probably the greatest contribution to the increase of per capita farm production has come through increase in fertilizer production and improvement in fertilizer practice, although there may be other claimants of the primary rôle. Long before the epoch-marking work of Liebig and of Gilbert and Lawes—about the middle of the last century—determined the direction of fertilizer practice, the importance of fertilizers in agriculture had been recognized, and the use of fish, marl, limestone, and gypsum had supplemented that of manures. However, it was only when the importance of the "limiting elements," nitrogen, phosphorus, and potassium, was recognized that fertilizer practice assumed its modern form.

To the supply of these substances chemists have made important contributions in the development of practically unlimited sources of potassium salts and suitable forms of phosphates, but more especially in the invention of a series of processes for the preparation of synthetic nitrogen compounds.

More immediate contribution by agricultural chemists is found in methods of examination of fertilizers to determine their plant food values and in establishing proper ratios of components for specific

purposes. Among the very many other contributions to knowledge which have summed up to the present situation only a few may be cited in illustration. The study of soil composition and particularly the recognition of the soil colloid as the active soil component have been important aids in crop adaptation and special methods of treatment of given soil types and soil areas. Soil acidity studies have not only been of use in crop selection and in increase of yield but have led to development of methods of soil amendment for special uses. The study of base exchange has led to modes of soil recovery and to determination of particular soil needs.

These and related studies have occupied the time and attention of a great group of chemists, for the most part associated with the various state experiment stations and the U. S. Department of Agriculture. The results of their work have found expression in publications of various types and through direct contact with producers. The end of such work is, of course, not yet reached or in sight. It is difficult to estimate the probable effect which will result from recent discoveries in fertilizer production and placement.

Another phase of the work of agricultural chemists has to deal with the part played by minor soil components in plant nutrition. It is found that minute quantities of particular elements are often of such importance that soils in which they are absent are relatively unproductive and even that animal diseases are due to these deficiencies. In some cases the addition of minute quantities of trace elements marks the difference between no crop and abundant yield. Still again traces of elements in soil produce injury to plants or to the animals which consume them. The developments in this direction are notable and promise to be of even greater future importance. This is the field of soil catalysis.

The counterpart of increased production by stimulation is to reduce loss through injury. In this direction also agricultural chemists have played an important rôle. With increase in mass production of commodities and the concentration of production of particular products in favorable localities and also as a result of increasingly wide distribution of fresh fruits and vegetables has come increased danger of inroad upon production from insect pests and from animal and plant disease. These dangers and damages have been met by chemists through the discovery of new and improved insecticides, by cheapened modes of production, by synthesis of new compounds and development of other remedial measures. The war of man *versus* insects is by no means won but it must be won.

Among other contributions of chemists which may be classed in the conservation group may be mentioned new and improved methods of food preservation; methods of obtaining and preserving fruit juices; useful transformation of farm wastes and by-products; and new and economical means of preparation of foods. There are almost countless others. The various modes of increase of farm production, whether by chemists or others, in the aggregate have placed far in the future any danger of fulfillment of the dire prophecies of Malthus. Indeed the human race, whatever its ultimate fate, need not die of starvation. On the contrary the opinion is held by some that the cooperative efforts sketchily outlined here have overshot the mark and that agriculture suffers from overproduction—or that we have needlessly large numbers of farmers. It seems difficult to believe this possible in a properly ordered social structure. The difficulty appears rather to be one of distribution. In any case the fault does not lie at the door of the chemist.

The second great contribution of the agricultural chemist is, as has been mentioned, in connection with prevention of fraud and of injury through exploitation.

In ye olden time when commodities passed directly from the hands of the producer and in the original form in which they were produced there was relatively little opportunity for fraud and but little incentive. As the distances in time and space between producer and consumer increased; as commodities became more and more concealed by manufacture and processing; as the use of cans, labels, and advertising increased, both opportunity and incentive to fraud increased and danger of injury grew greater.

The farmer who sells his cream for the manufacture of butter is easily defrauded unless he has available a cheap and convenient means of estimating butter fat. The public needs protection against the unscrupulous producer or distributor of milk: our modern farmer is not without guile. Protection in this direction was furnished by the devices of which Stephen Babcock was the progenitor. That abuses were gross and remedies urgently required the history of many industries show. Due largely to the labors and leadership of H. W. Wiley, aided valiantly by his co-workers in Washington and in the states, the food and drug act of 1906 made possible the control of the more dangerous practices. In this direction some states preceded the Federal government and all have followed. Today we have a large body of chemists whose business it is to see that suitable methods are available for the detection and

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The Contribution of the Chemist to Medicine for the Advancement of Modern Civilization

By M. L. Crossley, F.A.I.C.

Chief Chemist, Calco Chemical Company

TO place a value on the contributions of the chemist to the social growth and economic development of this country in specific industries is within the possibilities of statistical data. We may trace the development of an industry and measure its success in terms of its financial status. It can be shown that many of the good things of our present civilization are the direct result of the thought and work of chemists. From chemise to rouge are to be seen the results of his handiwork. In the transmutation of the common substances about us into new and useful material he has played a conspicuous part. Life is fuller and society richer by his work. The results of his work have benefited the entire public. These results may be measured in material values. However, these values are not the true worth of the chemist's service to humanity. The most significant contributions are above the value of gold and are not to be measured in terms of dollars or other currency.

This is particularly true of the contribution of the chemist to medicine and surgery. This is a romantic story of matchless beauty and enduring value. It is one of the most fascinating pictures in the great panorama of life. The chemist has helped to emancipate medicine from the dungeons of the supernatural. The superstitions of the past have given way to the persuasive power of reason and experience with chemo-therapy. Today medicine is largely applied chemistry. Pain is no longer the grim monster that it once was. Medicine and surgery are aided by the products created by chemists. Chemical substances suppress the sense of pain and give relief. These synthetic drugs permit the surgeon to explore almost every corner and nook of the human body, making adjustments wherever needed. The surgeon's knife is no longer an ally of death. Synthetic anesthetics dull the pain of the operation and antiseptics insure freedom from blood poisoning. The chemist, by his discoveries of drugs and their physiological actions, has banished suffering from the operating table, endowed the surgeon's knife with greater power to relieve pain and discomfort, and rendered microbes less potent as agents of infection and death. The chemist

has also gained access to the treasure vaults of knowledge concerning cellular activities, particularly glandular secretions. In the products of these secretions is the power to make us pigmies or giants, cowards or brave men, lovers or haters, thieves or honest men, wise or foolish, male or female. Health and life are bound up with chemical changes in the body. The contributions of the chemist to the safeguarding of health and the minimizing of the hazards of life, are among the most impressive of the many milestones marking the course of human progress.

It is not easy to apportion the credit for the work of chemists in this country. Like the beads of the rosary, the facts of chemistry serve for the prayers and manipulations of many. It is not always those who shout the loudest who work the hardest. Many noble souls are involved in the process of constructing the glory road but only a few are privileged to carry the battle flags in victory. We must not forget those who made victory possible.

In the triumphs of corrective and preventive medicine many chemists have played important rôles. To mention the names of some would be to do injustice to others. It is therefore wiser to stress the achievements of the chemist as the representative of his profession. The achievements of the chemist have been possible, in many cases, because of the cooperation of the biologist. He must not be overlooked in evaluating the results.

The major contributions of the chemist to the development of medicine in this country have been in the study of the processes of digestion, anesthesia, metabolism and glandular activities. With the use of ether it was shown that general anesthesia could be produced and patients saved the shock of surgical pain. Who is wise enough to measure the value of this contribution to the welfare of society? What scales of human values will we use to measure the significance of this discovery in the further progress of medicine? Fear, anxiety, pain, and suffering are destructive forces in life and their suppression must be in the interest of social good. The chemist and the physiologist have worked to make anesthesia possible with the maximum degree of safety to life and without damage to health.

The hazards to life and health have been materially lessened by the contributions of the chemists who have worked in this country to unravel the complex nature of the constituents of food and the processes of digestion by which they become available for the needs of the human body. From iron to blood and from vitamin to effect are represented struggles with the unknown requiring great courage and perseverance that success should be the reward.

The isolation of definite chemical substances from the secretions and excretions of the animal body and the study of their properties have had considerable influence on both corrective and preventive medicine. The chemical architecture of some of these products has been established and their counterparts produced from non-living material. This gives to medicine means for securing supplies of the necessary products and opportunity to study their effects in animals. It has been shown that some of these substances are powerful regulators of the activities of the human body. The elementary building stones are simple but the molecular arrangement has in each case been fashioned by nature to accomplish a specific result and it is always of a definite design. The chemist has been deeply concerned with the design and its relation to the effect obtained by using the product. How much is it worth to society to know how to prevent disease and maladjustments of the human system? Certainly it cannot be measured in money values but the intrinsic importance to life is of immeasurable benefit. With the knowledge of the nature of the chemical reactions in living processes, life itself becomes more interesting and real. Nothing is impossible; not even raising the dead.

With the knowledge now available the chemist should push on to greater achievements in the chemistry underlying human life and activities. He has isolated and identified certain hormones and ascertained their regulatory functions. He will now develop chemical methods for determining the appearance of these substances in the excretions and enable the physician to study the cyclic changes to which they are related. What greater contribution could be made to the health and happiness of mankind?

To Institute Members and Friends

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The phrase, "please patronize our advertisers," has been overworked by commercial magazines. In our case, however, it is vastly more significant. The more tangible benefit our advertisers get from their investment, the more advertising revenue we will have to improve our publication and to carry on our program of improving the professional standing of chemists individually and collectively. Therefore when we patronize our advertisers we patronize our own Institute and further the fulfillment of its ideals.

The Academic Contribution of the Chemist to the Dye Industry for the Advancement of Modern Civilization

By August Merz, F.A.I.C.

Vice-president, Calco Chemical Company

THE purpose of research is the acquisition of knowledge. When the knowledge acquired is restricted to private gain, the research may be said to be materialistic. If, however, the knowledge acquired is published for the benefit of science in general, the research from which it resulted may be said to be altruistic.

The distinction is very well set forth by W. C. Mendenhall in his obituary of David White, geologist, published in *Science* (March 8, 1935). Referring to White's many opportunities to capitalize his abilities and unique knowledge, Mendenhall states, "White was unwilling to enter an environment motivated by profit as its main object. Although some of his work had great economic significance, that was incidental to his research, and he preferred it so. The choice lay between applying his talents at a large salary, primarily to profits for a restricted group, with research as an incidental by-product, and applying them broadly, at a small salary, to a general service of mankind, with economic results incidental. There was never any hesitation on his part about the choice to be made." The same may be said of many American chemists whose lives were and are devoted to research for the sake of knowledge to be published for the benefit of science.

Secrecy is of such importance in commercial developments that obviously few chemists, excepting those holding positions in institutions of learning or in official laboratories, are at liberty to publish freely the results of their researches.

The evaluation of the results of materialistic research must be based on the products resulting therefrom. Even though these prove useful and beneficial to mankind and their practical value is acknowledged, there may still be no means of evaluating their scientific worth. When the results of research are patentable they are in due course published in the form of patent specifications, which contain as much or as little information as the inventor desires to disclose. Generally the disclosures are worded in a manner intended to hide rather than to reveal information.

The altruistic researcher has one fundamental basis for evaluating

his research. It is found in the answer to the question "what have I contributed to the fund of human knowledge?" Material gain accruing therefrom is incidental. Often it is merely a means to carry on further investigation.

In this age of materialism such altruism is apt to be regarded as almost a sign of imbecility. When we consider the values and benefits that have grown out of altruistic research we should be thankful that such altruism existed, and wish that it were more prevalent today.

Even altruists must eat to live. No matter how strong the urge, one cannot long continue to be an altruist unless there is available the wherewithal to keep body and soul together. Sometimes the altruist is recognized as a prophet of such importance that competition for his service advances his remuneration from a mere pittance to a sizable competence. Possibly he becomes infected by materialism. Then the world becomes poorer by the loss of an altruist.

Who can best afford to be an altruist in research? Naturally one who, because of his position in an institution of learning or in an institutional laboratory, can devote time to investigation, without any particular worry about the means needed to keep body and soul together.

There are many instances of great value and benefit to the world resulting from altruistic researches. America is still young in the chemistry of coal-tar dyes and intermediates. Organic chemistry itself is only a little more than one hundred years old. It had its birth in the discoveries of Wöhler about 1828. The first coal-tar dye resulted from the work of Perkin in 1856. The theory of the benzene ring was propounded by Kekulé in 1865. England and Germany were the centers of development and production in this branch of industrial chemistry. Scientific investigation naturally centered near the field of actual operation. There was little opportunity or incentive for investigational work in this branch of chemistry, in the United States. It is not surprising that our chemists applied their talents in other directions.

The works of some loom large and their names will ever be prominent as investigators and even more so as teachers and leaders who built for future strength in a field then much neglected in the United States.

Ira Remsen long held the chair of chemistry and later the presidency as well at Johns Hopkins. In 1879, he and his student, Fahlberg, were engaged in an investigation concerning toluene sulphonic acids and their derivatives. There is no indication that this research had any purpose other than the accumulation of knowledge. One of the products obtained was found to possess an intensely sweet taste. Thus saccharin became available to mankind. One of the great hardships suffered by

diabetics was the necessity for the elimination of sugar from their diets. The patient was forced to forego the use of sugar or suffer the consequences. With the introduction of saccharin there became available to the diabetic a safe sweetening agent which could be substituted for the deleterious sugar. The benefit to those suffering this dread disease has been immeasurable. The demand for the product opened a new branch in pharmaceutical chemical manufacture, giving employment to those directly engaged in its production and to others engaged in the manufacture of necessary adjunct chemicals.

In addition the process yielded isomers other than those leading to saccharin. An outlet for these had to be found to insure to the process a greater economic success. In due time further research enabled their application in the manufacture of dyes. The whole subject of sulphochlorides, corresponding amids and esters was studied, resulting in an accumulation of stores of information which have been profitably applied industrially as well as scientifically.

The fact that Remsen was deprived of pecuniary benefit from the result of an investigation carried out under his direction is one of the sad twists of fate which so often occur. E. Emmet Reid wrote: "Remsen came into American Chemistry during its formative period, when his leadership counted for most. Many who were later to mould chemical thought were moulded by him. He taught a few hundred, they taught many thousands. Comparatively few of his students went into commercial chemistry, but a number of these have been prominent figures in some of our largest industries and have carried Remsen's ideals with them. He has never taken out a patent or turned his hand to commercialize any of his discoveries, and has always taught pure chemistry, and yet few men had so great an influence on applied chemistry."

Elwood Hendrick, who played an active part in the early attempts to build a dye industry in this country and was therefore able to appreciate the efforts of the pure scientist, wrote of Charles F. Chandler: "He was a catalyst to encouragement, for he had the remarkable faculty in making men believe in themselves." Hendrick relates that when Chandler returned from Göttingen, where he received his degree, he applied for an assistantship under Professor Joy at Union College. The only position available was that of janitor at $400.00 per year. Without hesitation Chandler accepted, and proceeded to sweep and clean the laboratory before and after hours, with pay, and between times during official hours he instructed and assisted without pay. When Professor Joy left Union, Chandler, then at the age of twenty,

was appointed in his place. Later he again succeeded Joy at Columbia, where he spent the rest of his career, moulding and shaping many chemists who in their own time became outstanding figures in both pure and applied chemistry in its various branches, including that of coal tar dyes and intermediates.

William R. Orndorff, a pupil of Remsen, was another remarkable teacher and a devotee of pure research. He and his students carried out a systematic research on the phthaleins. It still is a splendid contribution to the scientific knowledge of this class of compounds. The question of commercial value does not appear to have been the motive actuating this investigation. Orndorff inspired his students, many of whom have found their places in this branch of chemistry.

As a part of the course of training, Orndorff wished to have his students carry out a study of the indigo synthesis from naphthalene to dye. His students were unable to obtain reasonable yields of phthalic anhydride by the sulphuric acid oxidation of naphthalene even though the method was described in the patent covering the process. Gibbs, a former student under Orndorff, and then chemist in charge of the Color Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture, was told of this difficulty by Orndorff. He had heard this also from others interested in the product from an industrial viewpoint. That was during the early days of the great war when there existed in this country a virtual famine of both dyes and intermediates.

Gibbs undertook a study of the process with the hope of being able to assist the chemical industry. He soon abandoned it in favor of a catalytic air oxidation process developed by himself and Conover. A patent was issued to them and was assigned to public benefit. Under these conditions there was no prospect that the inventors would personally profit by the invention. That they did so later by finding employment with companies desiring their services was good fortune well deserved.

Through the application of phthalic anhydride in resins and plasticizers its consumption increased many fold beyond the amount originally required for the production of dyes and phenolphthalein. That later a German chemist was able to prove priority by a very narrow margin over the American inventors was just another of the fortunes of war.

A large part of the present-day lacquer and alkyd resin industry is based on the use of phthalic anhydride. Much of this is an independent development by the American chemist which can be credited to the phthalic anhydride researches of Gibbs and his co-workers.

Professor John Howard Appleton, another great teacher and scientist, loved research for the sake of the knowledge acquired. He devoted

much of his time and means to a scientific study of the constitution of commercial dyes. These dyes were to a large extent covered by patents and there was little hope of monetary gain to be obtained from information resulting from investigations of dyes as to their chemical compositions and structures. Appleton inspired in his students an appreciation of the effect of constitution on color. Many of his students later found their activity in the fields of textile and dye chemistry. Such inspiration is bound to have a beneficial effect on the career of the student, be it in the field of pure or applied science.

Alexander Smith came to this country from Scotland. He soon made his mark as a teacher and also as an investigator. His researches were mainly in the inorganic branch. His publications on sulphur are still classic. He was one of the pioneers in physical chemistry in this country. His influence becomes more and more apparent with the ever-increasing application of the principles of physical chemistry to the study of organic reactions.

J. U. Neff was a pupil of von Bayer, von Bayer was a pupil of Kekulé, Kekulé was a pupil of Liebig, and Liebig was a pupil of Gay-Lussac. What a heritage! Neff's studies on tautomerism, keto-enol forms and bivalent carbon paved the way for much that has since developed great value, both scientific and commercial, in the field of dye chemistry. The fund of theoretic and practical information based on these researches is invaluable and yet Neff probably profited not one penny by it. He no doubt felt well repaid by his success in achievement. Science is the richer because of his labors and industry is able to operate the better because of his explanations of keto-enol tautomerism.

Edgar Fahs Smith, a great character, and a tower of strength in the development of American chemists, devoted his entire career to teaching and investigation. Needing textbooks for his students, he translated the best available from other languages. When these did not meet his requirements he wrote new textbooks. An enthusiast on the chemical development in America, he found time to compile historical articles on that subject and also on the men responsible for that development.

Truly he was a great teacher, a moulder of men, instilling high ideals in his students, many of whom have in their turn contributed greatly to this industry.

Remsen, Chandler, and Edgar Fahs Smith were great teachers of their time. Men of such personality and ability are outstanding at any time. Their influence was all the more important because of

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The Contribution of the Chemist to the Printing Ink Industry for the Advancement of Modern Civilization

By L. F. Engelhart

International Printing Ink Corporation

PRINTING and the forerunners of printing as the Papyrus and the Book of Rocks have been the record mediums of the great drama of life and, furthermore, have been the prime and almost only means of recording all human knowledge even unto our present date. Printing Ink and Paper are often personified as the hand-maidens of Printing, and rightly so, since the triad of press, paper, and ink have been inseparable in their development and improvement from the day of Johann Gutenberg to our present era.

Printing ink, through means of books and periodicals, has enabled man not only to communicate his thoughts when separated by hundreds and thousands of miles, but has also enabled mankind to record these thoughts and experiences for the benefit of posterity. It has, therefore, become one of the most tangible means of improving the social life of humanity, promoting education, and expanding and perpetuating our civilization.

Hence, the chemist may feel justly proud of whatever association and contribution he has made to this industry which in conjunction with printing has represented human thought for the last four and a half centuries—without break, without gap. The chemists' contributions to printing ink have been many since the birth of the industry, but his direct association in formulation and manufacture has taken place only within the last 50 years or so. However, like technological developments in general, more advance has been made in printing and printing inks in this last 50 years than since the first European printing from movable type by Gutenberg in 1450 A.D.

Incidentally, Gutenberg was not a chemist; yet, he was his own inkmaker and his ink, to some, would seem to be rather similar to our modern news inks, namely, to consist of a carbon pigment and an oily vehicle. Nevertheless, from a physical property and production basis, the old and the modern inks would be as dissimilar as the rate of speed at which they were designed to be printed. Gutenberg was hustling when he obtained as many as 100-single sheet impressions an hour,

whereas, it is common occurrence for modern high-speed newspresses to print from 45,000 to 60,000 complete, cut, and folded editions in the same period.

This increased the tempo of modern life, reflected in multiplied mechanical intricacies and ever-increasing production speeds, and has found its echo in the printing and the printing ink industries. It is in this comparatively recent speed increment of printing that the chemical engineer and physical chemist have been of outstanding service in ink and paper formulation as well as even being influential in certain phases of press design.

To the layman, probably the most noticeable change in printing inks has been the strongly increased use of color in the last decade or two. America, as well as most of the rest of the world, has most assuredly become color-conscious. Color is one of the greatest attention-getters known to advertising and its use is constantly increasing as a survey of recent pamphlets, periodicals, newspapers, bill-boards, and packaged merchandise will quickly substantiate.

Here, in the color field of printing inks and the decorative arts, the chemist has been pre-eminent in their inception, development, and production. During the seventeenth century practically all the colored inks produced were made from the natural inorganic or mineral earth pigments. The formulation of *Prussian Blue* by Diesbach in 1704 and the discovery of the first aniline dyestuff, *Mauve*, by Perkins in 1856 together with prodigious amounts of supplementary work by ensuing chemists made possible this brilliant array of colors that the graphic and decorative arts are so ready to make modern use of.

Likewise, in the development of vehicles in which to disperse the above colors, to carry them through the printing or application process, and finally to cause them to adhere permanently to the printed material, the chemist has played an all-important rôle.

Not only is the chemist responsible for the raw materials and much of the formulation of modern printing inks, but he furthermore should be given much of the credit for the development of all three of the important printing processes now in use.

The birth of the art of photomechanical engraving, which includes line etchings, half-tones, and even photolithography, dates from a discovery by Fox Talbot in England in 1852. Further development by Ives in 1881 and Levy shortly thereafter made modern typographic, or relief, printing possible. In a like manner, intaglio or rotogravure printing was made possible by the process originated by Karl Klic in

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The Contribution of the Chemist to the Rubber Industry for the Advancement of Civilization

By Harry L. Fisher

General Laboratories, U. S. Rubber Company

THE chemistry of rubber is incompletely understood, and the chemistry of the chief process by which rubber is made useful is very inadequate. Yet, in spite of these apparent shortcomings, the rubber industry has grown enormously. By definition, chemistry is "a science that treats of the composition of substances, and of the transformations which they undergo," and a chemist is "one versed in chemistry." If this is the case, where can the line be drawn to distinguish an ordinary experimenter from a chemist? When does one become the other? May it not be well to include in the definition of a chemist one who uses chemicals to such good advantage as to produce new and useful goods? If this is acceptable, then it is possible to go back many years in order to begin to outline the contribution of the chemist to the rubber industry.

Was Charles Goodyear a chemist? His record shows that he was a hardware merchant and a handy man with tools, and yet he made the outstanding contribution to the rubber industry. His discovery of vulcanization should certainly classify him as a chemist. Hancock, the indefatigable English rubber experimenter and manufacturer, working all alone long "after hours" in his improvised laboratory, invented many methods of producing useful articles of crude rubber, and when shown a piece of "changed" rubber prepared by Goodyear, recognized the odor of sulphur in it, and with this observation in mind rediscovered the method of vulcanization. Was he not also a chemist?

Earlier work on the application of rubber was by natives who made shoes and waterproof clothing. Brazilian Indians two centuries ago used gun powder to mix with rubber latex to give a non-tacky surface to the shoes prepared with it, and some of these shoes, which have aged remarkably well, upon analysis have been found to contain as much as $2^1/_2$ per cent. of chemically combined sulphur—a definite sign that vulcanization has taken place through the years. It might also be mentioned that one such shoe still contains round rubber laces!

Other work before the discovery of vulcanization involved the spreading of a solution of rubber on cloth for raincoats, etc. The rubber was

sticky and an extra layer of cloth was used by Macintosh to get rid of the sticky surface, and the name of the inventor has continued to this day as a synonym for raincoat. These raincoats, however, were useless in midsummer because the rubber became soft and tended to "run" and stick, and in winter since the rubber became hard and stiff, they became unyielding like a one-piece coat of armor.

Crude rubber of good quality is tough, strong, resilient, elastic, and fairly resistant to abrasion (witness its use as crêpe rubber soles), but these qualities obtain only at the ordinary temperature, as intimated above. By means of vulcanization, however, they can be greatly enhanced and made to hold over a wide range of temperatures. Crude rubber on a very cold day in winter is hard and inelastic, but every one knows how resilient and elastic the modern tire is even on the coldest day in winter. Furthermore, these qualities are retained even at the high temperatures, 350° F. (176° C.), sometimes found in bus tires on the road in our southern states in summer. Of course, the first tires of thirty or forty years ago did not behave so well, and that is where the work of the chemist has come in.

Fine Para rubber, unvulcanized, ages very well because of the presence of naturally occurring anti-oxidants. Some plantation rubbers, however, and especially rubber which has been "worked" on a mill or has been in solution and allowed to stand in air and light, become sticky. This is caused chiefly by the action of air. In the early days, many substances were used on crude rubber to prevent or remove this stickiness. Goodyear invented a process involving the use of nitric oxide gas which reacted chemically with the rubber and produced a non-tacky rubber derivative. Unfortunately, this was only a surface reaction, the surface film was hard and brittle, and when worn away, the newly exposed rubber surface became soft and sticky. Goodyear almost lost his life in trying to perfect this process. The use of sulphur to prevent stickiness was patented by Hayward, and this substance worked well because it also dissolves in the rubber. Goodyear bought this patent, and it was while experimenting on the action of heat on one of his compounds, which happened to contain both sulphur and white lead (an inorganic accelerator), that he discovered the "change," which later was termed "vulcanization" by Brockedon, an English friend of Hancock.

The rubber industry as it is today would be impossible without the plantations in the far east. Here also the chemist as well as the botanist has had much to do with increasing both the quality and the yield of crude rubber. The earlier yields of three hundred pounds per acre have been more than doubled, and special clones of trees have yielded

over two thousand pounds per acre! In 1900 only four tons of crude rubber came upon the market while Brazil and the other rubber-producing areas exported 54,000 tons. Last year (1934), however, the amount of rubber from the plantations was close to the one million mark, 991,846 tons, and the "wild" rubber amounted only to 11,715 tons. Three-fourths of all this rubber, by the way, is made up into tires and tubes.

The manufacture of hard rubber followed a few years after the discovery of vulcanization. Soft vulcanized rubber requires only 3–5 per cent. of sulphur but hard rubber uses around 28 per cent. of sulphur. If the rubber is chemically saturated with sulphur, the product contains 32 per cent. of sulphur. Hard rubber can be moulded and machined, it is very strong, its tensile strength being upwards of 8,000 lbs. per square inch, it is a very good electrical insulator, is water resistant, and insoluble in all known solvents, as well as unattacked by corrosive liquids. It is because of these properties that its use is widespread. The early fountain pens were all made of hard rubber, and combs, battery jars, etc., are also made of it.

Hard rubber is thermoplastic, that is, it softens at high temperatures and hardens again after cooling, with no apparent change in its properties. On this account hard rubber can be transformed into different shapes. For this purpose it is first powdered in a special grinding machine. The process of grinding is attended with a considerable hazard of dust explosions, but the chemist has prevented these by the use in the grinder of flue and other inert gases. The dust is moulded in plunger moulds at about 390° F. (200° C.). The most familiar objects moulded of hard rubber dust are the mouth pieces and receiving parts of telephone instruments.

The greatest contribution of the chemist to the rubber industry within recent years is the discovery of accelerators of vulcanization and of anti-oxidants. Accelerators, as their name implies, accelerate vulcanization and therefore shorten the time. This shortening of the time allows moulds to be used over and over again in the same time as previously and thus increases the "turn over" and diminishes the overhead expense. Goodyear's process required three to four hours at 287° F. (141° C.), but "ultra-accelerators" shorten this time to as low as two or three minutes. The latter will also act at lower temperatures, some of them acting even at room temperature although the time then becomes extended to hours or to days. Not only is the time shortened, but physical qualities are generally improved— increased tensile strength, tearing and abrasion resistance, better aging, lower solubility, etc.

The amounts required vary from about one part on one hundred parts of rubber to 0.1 part and sometimes less. The saving to the American public by the use of accelerators amounts to many millions of dollars annually.

The occurrence of anti-oxidants in crude rubber was mentioned above. These substances, however, during the vulcanization process, are destroyed by the action of the heat. As also mentioned, many accelerators give very good aging compounds, but the use of accelerators varies very much according to the type of vulcanizate required. Accordingly, the advent of anti-oxidants which do not accelerate or change the action of the accelerator, made it possible to add them to almost all types of compounds with the assurance of good aging. Rubber products which previously could not be considered are now in use and proving their good worth as structural units in buildings and automobiles. The new stream-lined railroad trains probably could not have been brought to their state of quiet running were it not for the use of good aging rubber. Along with the production and use of anti-oxidants came also accelerated aging tests in order that the chemist and the rubber compounder could develop new anti-oxidants and new rubber compositions whose aging under ordinary conditions could be foretold years in advance.

Not only is rubber used for helping to make automobiles, trains, trolley cars, and aeroplanes quiet running, but it is also used as vibration dampeners on motors and machinery, and as shock absorbers in rubber heels, tile flooring, mats, and street paving. In this general category, the use of rubber in automobile tires is, of course, most outstanding.

Rubber latex is being used more and more in the manufacture of rubber goods, and is being extended into the paper and fabric fields. The work of the chemist in these developments is especially noteworthy. Latex gloves, insulated wire, raincoats, sponge, tubing, hospital sheeting and supplies, baby's garments, bathing caps, thread, have all proved their worth in lower cost of manufacture and improved quality. The rubber in articles prepared direct from latex has never been "worked" on a mill and therefore contains no grain, is stronger, more tear resistant and generally better aging than when handled by the older processes.

Reclaimed rubber, which is re-plasticized vulcanized rubber, is another contribution of the chemist. Upward of 200,000 tons a year tell the story of its value. Synthetic rubbers, also, are on the market and, although expensive, are taking their place on a quality basis—

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The Contribution of the Chemist to the Precious Metals Industry for the Advancement of Modern Civilization

By C. M. Hoke, F.A.I.C.

Jewelers' Technical Advice Corporation

I GRASPED my pen and leaned forward to consider this rather portentous title. . . Does every one chew his pen when deep in thought, I wondered? . . . And then I laughed to myself, for there was my gold pen point, tipped with iridio-platinum; and the very teeth against which I had been tapping its handle were themselves encircled by a tiny strip of metal—precious metal—a mere thread, but strong as steel and much more permanent. Two examples, I found there—literally under my nose—of the benefits that had been brought to *me* by some forgotten chemist who had worked in precious metals! How easy it is, I thought, to accept these blessings without comment or gratitude!

Precious metals have always been important in human society—too important, you might say—from pre-historic days down. So it is a pleasure now to recall and relate how many times in recent years chemists have contrived to make them a means to health, happiness, and wisdom—rather than merely an outward sign and token of wealth.

By precious metals we mean gold, silver, and now platinum and its group of palladium, iridium, rhodium, ruthenium, and osmium; the whole history of the latter lies within the period of this discussion.

Coinage and the arts have used up a conspicuous proportion of the world's gold and silver; and it must be confessed that within these fields recent research has made few conspicuous changes; Roman coins are not so greatly different from the coins of today; Roman ornaments are plainly the sisters of the ornaments of this day of grace. But precious metals are also used—less conspicuously—in industry, in advertising, in medicine, sanitation, education, astronomy, dentistry, electrical work, photography, and probably a dozen other lines.

This is a formidable list, and it includes many of the agencies that make men healthy, wealthy, and wise—and therefore happy.

Simply to list the applications that chemists and physicists have made, or have enabled others to make, of precious metals, will to the informed reader be enough to expand his appreciation of the chemist himself as an agent of good.

One of Rudyard Kipling's noblest poems contrasted the Sons of Mary and the Sons of Martha. Mary was the one who sat and listened; Martha was the sister who busied herself with many tasks. And the Sons of Martha are the doers, the workers, who modestly, quietly, anonymously, cushion the shocks for those lordly Sons of Mary who ride on at their ease. He listed the Sons of Martha—the miner, the electrician, the architect, the engineer of land and sea; but even here, even in this effort to praise the nameless worker for human good, even this poet did not specifically mention the chemist. . . .

Possibly that was Kipling's fault; but I think it was mostly the fault of the chemist himself. He is as modest, as self-forgetful, as the engineer, and he works just as inconspicuously, just as modestly. And he never blows his own horn. Let us therefore blow his horn for him, by listing some of the things he has done for humanity and its happiness and health:

Fountain pen tips . . . Small things in themselves, but how much they have added to human happiness and ease, with their bright gold bodies, and the slow-yielding hardness of their tiny tips, crowned with native crystals of iridio-platinum!

The devices used in surgery. . . These also are small in themselves; a hypodermic needle of iridio-platinum is scarcely larger than a hair, but its help in the alleviation of pain is a mighty blessing. It is only one of the many applications by means of which the precious metal worker has served medicine.

The metals used in dentistry. . . Today's dentistry may be divided into the *orthodontia* that takes care of the straightening of the teeth of children; *prosthetic* dentistry, which concerns itself with the restoration of lost teeth; and *prophylactic* dentistry. All three of these branches use precious metals; the orthodontist uses bands of gold to bring irregular teeth into line; sometimes the metal must be soft and flexible; at other time stiff and tough. Prosthetic dentistry requires the soft almost pure gold used in filling cavities, casting golds, iridio-platinum pins of supreme strength and specific melting point, and a wide range of other precious metals of specific characteristics. The researches and labors that lie behind these alloys have been carried on by chemists and physicists in our Government laboratories, as well as by workers in commercial laboratories. Both groups are equally modest, equally unknown to personal fame, equally deserving of the gratitude of the humanity whose health they have served.

The art, science, business, and sport of photography . . . Whatever we call it, we cannot ignore its importance, either as a factor in human

life or as a consumer of silver. Most of the fundamental work on which it is based was done by chemists. Its ramifications continue to utilize the services of hundreds of chemists today. Few if any influences of the last three hundred years have carried equal power to shape human thought, foster human education, or further human brotherhood.

Electrical equipment . . . In the manufacture of X-ray apparatus, electrical contact points, etc., platinum is a useful and inconspicuous servant, as useful and as inconspicuous as the men who brought it into these fields. Ours is called an electrical age, and the precious metals worker is one of its foundations.

Chemical equipment . . . Here the lines in the flow-sheet of human progress may be said to loop back upon themselves; the precious metal chemist has developed tools for his own trade which then have served to make the trade more useful in a multitude of new lines. It has been said that without platinum crucibles we would not to this day be able to analyze most rocks. Improvements in the manufacture of laboratory apparatus are still going on; crucibles are purer, thermo-couples are more dependable, wire and mesh are finer and more uniform, through the services of chemists in commercial laboratories.

Artificial silk . . . A new product, one that has made life gayer for some, busier for others, is indebted to the precious metal chemist and technician for the spinnerets by which the threads are spun.

Electroplating, including rhodium plating . . . A new science, wholly chemical and physical in its origin, brings beauty and economy to many fields. Recent work has tended to bring safety to the workman, for the removal of the hazards of operation.

Sanitation . . . Another young science, its only reason for existence being human well-being, owes a debt to the precious metal worker. Colloidal silver promises to be of importance in water purification. Silver apparatus has been essential to the development of methods of chlorination.

Astronomy . . . When precision of the highest order is demanded, the precious metals always play a part. The mirror backed with palladium is only one of the devices used by the astronomer.

Warfare . . . Not a source of human happiness, not a source of human enlightenment, but to some individuals a source of profits, the science of warfare may perhaps be mentioned in this list. Here again we find the palladium mirror, used in anti-aircraft searchlights; the platinum apparatus used in almost every branch of chemical warfare, the preparation of explosives, the platinum parts in electrical equipment, and—I mention this to keep us from becoming too solemn—the gold in the gold braid.

Jewelry . . . . Is this an art that brings happiness and health? I think it is. Its close relative, horology, is surely a member of the family of useful arts. Within three hundred years there have been numerous improvements in the technology of precious metal working, some of which (such as gold leaf and rhodium plating) have added to the beauty of our ornaments, others of which have contributed mainly to the economy of the jewelry maker, and most of which have been accomplished by chemists.

In contemplating this list, it is arresting to observe how few if any of the *names* of individual workers have been brought to mind. When I speak of fountain pens, I think of Waterman; when I mention dentistry, I think of toothpaste; when I say photography, I am as apt to think of Greta Garbo as of Eastman or Daguerre. Even the briefest glance at this list convinces the reader that whole armies of patient and competent workers have stood behind it, and are at present engaged in holding and advancing its frontiers. And yet, how many names come to your mind? Even those of us whose work is among these metals, even we who read the abstracts and trace back the references—even we must admit with shame that we do not know even the names of most of our pathfinders in this field of endeavor. Or if we know a name, it is merely a name—not a well-rounded conception of a human being.

Certainly this last arresting fact would alone justify the existence of The American Institute of Chemists. It is high time that these good and faithful workers should be accorded the recognition that is their due.

Contribution of the Chemist to Agriculture

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estimation of adulterants of foods, drinks, and drugs, and to apply these methods to specific cases. The net result of this public service is a degree of protection of the public health and private purse which is beyond estimate in the ordinary terms of value. The total comprises no mean contribution to social welfare, and the present efforts to broaden the scope of such work deserve support.

Even were it possible it is perhaps undesirable to single out the individual contributors through chemistry to the general welfare. There are a host of them. Chemists are not sufficiently class conscious. For the greater part they live relatively obscure lives in rendering service all too frequently undervalued. Of the work of the agricultural chemists we are proud, and of its enormous value we are very conscious.

The Contribution of the Chemist to the Plastics Industry for the Advancement of Modern Civilization

By R. H. Kienle, F.A.I.C.

Research Chemist, Calco Chemical Company

THE 89th meeting of the American Chemical Society in New York the week of April 22nd–26th not only assumes the character of a scientific meeting but this year commemorates the Tercentenary of the founding of the American Chemical Industry. It is only natural that at such a time the chemist review the contributions he has made, and that he analyze his activities. This review may assume many forms, such as: his contributions through the chemical industries to our national economic structure; the part he has assumed in our modern industrial structure; the contributions made to the advancement of our scientific knowledge and understanding; the actual industrial development of a particular branch of chemical industry. A most interesting review concerns his contributions and advancements to human welfare which lead to greater comfort and happiness. It is in this way that the chemist really functions toward society in the practice of his profession.

In our present economic structure the chemist acts largely through organized industry. We, therefore, have to turn to industry to get the picture of the chemist as he performs his professional duties. As an interesting field to survey, we can take synthetic resins and plastics.

Man for centuries has been interested in and has used resins and plastics. The ancient Egyptians and Chinese used natural gums and resins in various formulae and for various purposes, such as for binders, varnishes, etc. The natural bitumens were in more or less common use with ancient man. The native South Americans were quite well aware of the properties of latex, properly coagulated, as a plastic.

During the major part of the three hundred years of chemistry in this country, natural products have formed for the chemist the raw materials in the resin and plastics field. In the professional service rendered man, he has extensively used these materials.

The natural resins, such as the copals, kauri, rosin, etc., have been blended with drying oils, solvents and pigments added, thus yielding paints and varnishes which enriched, brightened, and preserved man's shelter. Compounded slightly differently, the chemist from the same

general raw materials produced ink so that man could communicate with his fellow men, so he could permanently record his observations, thoughts, and sayings. Still, from the same raw materials but processed yet another way, the chemist prepared the plastic, linoleum, which has served to give man a floor covering for his workshop, office, and home, which is quiet to walk on, serviceable, easy to clean, made in numerous designs, some equalling the intricacies of the ancient rugs and carpets.

In the case of a number of the natural resins, the chemist has gone further. In his studies thereon he has observed certain characteristic properties which he has in turn developed for man's use. Thus in the case of rosin, he found it would act as a sizing for paper. Also he found it could be reacted with glycerine to form an ester, ester gum, which had special value in the paint and varnish industry in that, when properly cooked with China wood oil, a varnish results with exceptional water resistance. Man has benefited thereby in the improved protection afforded his goods to water and the elements.

Furthermore, in the chemist's study on shellac, he ascertained its adhesive properties and thermoplastic characteristics. It would be difficult to build large power transformers without shellac bonded cylinders on which to place the windings; and even harder to generate the electric power that the transformers place at man's disposal without the use of commutators on the generators in which the copper segments are insulated, one from the other, by shellac bonded mica.

By carefully compounding shellac with fibrous and mineral fillers on suitable mixing rolls, sheeting, and hot pressing, the chemist gave man the Victrola record which permanently records the voice or song of the great masters, and carries it to the ears of everyone, preserving it for the future man as well.

The natural bitumens and asphalts have also been used in this rendering of service to man. They have been converted into roofing plastics, shingles, etc., aiding man in obtaining better and more economical shelter. The chemist has also converted them into road-construction plastics so that today, together with cement, a plastic developed from natural inorganic deposits, man possesses highways beyond the dreams of even as recent as two decades ago. To complete our picture of natural resins and plastics we must not overlook rubber.

The greatest contribution of the chemist in the resin and plastic field probably was in the adaption thereto of synthetic organic chemistry. Starting with the first organic synthesis by Wohler, 1828, and followed by many other chemists such as Berzelius, Perkins, Beyer, Fisher, Baekeland, there has been a gradual building up of scientific facts and

methods of organic synthesis leading to the control of the phenol-formaldehyde reaction products and to the discovery by Dr. L. H. Baekeland about 1907 of their convertibility under heat and pressure to a useful gel. This was undoubtedly a very important milestone for the chemist in his professional service to man. In reality it marked the establishment of our modern synthetic resin and plastic industry.

Prior to this the chemist had, of course, given man the process of vulcanizing rubber and established the modern rubber industry. He also had taken cotton or cellulose, nitrated it, mixed it with camphor, pigments and other ingredients and made it into the thermoplastic celluloid, which in turn was formed under heat and pressure into useful articles for man, such as combs, brushes, containers, toys, etc. This same material the chemist converted by dissolving in suitable solvents, into lacquers which could be pigmented or colored and used as quick drying protective coatings. About 1921 the chemist discovered how to lower the viscosity of these lacquers, how to improve adhesion by adding resins, how to improve flexibility by adding plasticizers which established in turn our modern lacquer industry of invaluable service to man in his modern living.

His cellulose studies and investigations lead the chemist still further onward in rendering professional service. He learned how to dissolve cellulose and regenerate it as a sheet or thread which gave man respectively Cellophane and artificial silk. Furthermore, he ascertained how to make other derivates of cellulose such as the acetate, ethyl cellulose, and benzyl cellulose. These he has converted into artificial threads, into films, sheets, etc. The acetate, with its greater permanency and non-inflammability, has given man non-inflammable X-ray films, moving picture films, stronger artificial fibers than natural silk, and safety glass. One has only to imagine life without these products to realize the service rendered by the chemist.

Dr. Baekeland's discovery injected two new factors into the resin and plastic industry: first, the importance of the amorphous products of the synthetic organic chemist as well as the crystalline; and second the heat convertibility of resins or, scientifically speaking, the sol to gel transition. The first factor directed the chemist's attention to innumerable new products which he has since and still is actively preparing, investigating, cataloguing, and bringing to the service of man. Very recently the chemist has begun to see that there is an order in the amorphous world as well as in the crystalline world, and with this understanding he has begun to synthesize products with predesired properties. The second factor introduced a new characteristic for chem-

ical materials into industry and drew attention to a property which was very serviceable to man in nearly all branches of his endeavor. The older plastics which were all heat non-convertible or thermoplastic had limited usefulness, particularly where solvents and temperatures were encountered. The new products which were heat convertible or thermosetting did not possess these limitations. They were solvent and temperature resistant.

During the past two decades the chemist has been very active in his survey of the amorphous organic world for synthetic resins and plastics. As a result, he has, in addition to the phenolic resins produced resins from urea, aniline, acetylene products, hydrocarbons, sulfamides, vinyl derivatives, polyesters, polyamides, etc., thus giving man a wide variety of products with varying combinations of properties, often differing materially from any combination available in nature.

From urea and formaldehyde, the chemist has produced a colorless, heat convertible resin. Molded articles, of all sizes and shapes, and laminated panels of varying dimensions have been made from this resin in all shades and tints from white to black.

The chemist has made a series of phenolic casting resins which, when properly colored, duplicate the richest gems and jewels of the ancients.

In the field of the alkyd or polyester resins, the chemist has introduced oxygen reactivity into the resin molecule so that resins are now available that gel in the air by oxygen absorption as well as by heat. Here is a single phase material, under accurate manufacturing control, that acts in solvents like a lacquer, that dries like an oil varnish, and that possesses remarkable adhesion and durability.

The chemist has also synthesized from methyl butadiene a rubber. By modifying this hydrocarbon, that is by forming chlor butadiene and polymerizing, he has not only produced another rubber but induced oil-resisting properties not found in natural rubber. From the alkyd resins and from the reaction between ethylene dichloride and sodium polysulphide, the chemist has produced artificial rubber, differing widely in chemical constitution from natural rubber but closely resembling it in physical properties.

These are but a few cases of the professional service rendered by the chemist in the field of synthetic resins and plastics. It is hoped that these few cases will be sufficient to point out wherein the chemist, through the new products and materials made available in this field of chemical endeavor, has advanced human welfare and increased human comfort and happiness.

The Contribution of the Chemist to the Fertilizer Industry for the Advancement of Modern Civilization

By W. S. Landis

Vice-president, American Cyanamid Company

THE very earliest records pertaining to the use of fertilizers for increasing the yield of grain have little relationship to the chemist. Far back in antiquity it was common practice to bury a corpse in the corner of the grain field. At first it was the body of a slain enemy; human sacrifice furnished the body at a later date; and still later an animal carcass was found to be quite as efficacious. The ceremony of burying an animal in the grain field at seeding time persists today in some of our less highly developed agricultural regions.

Prior to the beginning of the 19th century the use of stable manure for improving the yield of crops was practised in most agricultural regions. The benefit of lime was known to the Romans who introduced its use into France and the British Isles and neighboring countries. Its use was practised in America at least as early as 1645, the source being shells burned on an open fire.

Wood ashes as a source of potash were known to the Romans, probably even known in earlier times. The earliest records of our farms describe the ash hoppers, though probably their function was to supply alkali for the soap industry since the ash in its natural form is better adapted to agriculture.

Gypsum had been used in Europe for some time and was introduced into American agricultural practice about 1770 through the German farmers who brought over the idea. Benjamin Franklin himself called attention to its agricultural value when he applied gypsum to a grass plot so as to spell out a simple advertising slogan through the more luxuriant vegetation and darker color of the grass where the gypsum had been applied.

The discovery of the value of nitre or saltpeter for agricultural purposes is credited to Johann Rudolph Glauber, thus bringing the first name truly identified with our science into the agricultural field. However, when the first shipment of Chilean nitrate, which reached England in 1830, was checked and found not to contain potash, it was thrown overboard.

I have picked the beginning of the 19th century to begin our real history of the contributions of the chemist because it was just about that time that Malthus published his thesis on the relative rates of increase of population to food production. From a mass of statistics he advanced the proposition that population increases geometrically and that food supply can at best increase only arithmetically. This led to his conclusion that the future development of population would be limited by starvation. His conclusions have been the subject of much controversy. During the past 140 years it has been comparatively easy to support his thesis by reference to backward countries densely populated. However, it should be noted that the chemist has not been particularly prominent in those same countries. (This dispute is intensified in the conflict surrounding our own AAA.) I am not going into the Malthus data but since this announcement appeared at approximately the same time that the chemist began to interest himself in the agricultural field, we shall examine briefly the contributions which the chemist has made to the agricultural problem, since Malthus' time.

The Swiss chemist, Sassure, in 1804 made the first real chemical analysis of plant composition. A few years later Sir Humphrey Davy interpreted the then existing practice of agriculture into chemical terms. Today we do not recognize either of their contributions as authoritative and it was not until toward the end of the third decade of this century that a real chemical foundation for plant feeding arose. The establishment of the Rothampsted Experiment Station just north of London in 1837 by John Lawes marked the first application of chemical science to plant feeding. Justus von Liebig published in 1840 his treatise on plant nutrition from the chemical standpoint. Lawes employed Dr. Henry Gilbert, a chemist trained by Liebig, to control the work of the Rothampsted Station, and made accurate studies of the effect of nitrates and ammoniates, phosphates, and potash salts on the growing of wheat, all under exacting analytical control. Liebig devoted his attention particularly to carbon and nitrogen and a dispute of long years' standing as to the source of nitrogen arose between Lawes and Hall in England, and Liebig in Germany, which was not settled until 1880–1890.

About this same time Boussingault in France—frequently called the founder of modern agricultural chemistry—busied himself with a study of the mineral constituents and nitrogen in soils and plants. His early reports of 1838 were really only first made available in 1865. As mentioned above, during the next four decades there was a dispute on the nitrogen problem which was finally settled by a series of reports of

investigations coming from Berthelot in France, Atwater in the United States, and Hellriegel and Wilfarth of Germany.

The value of ammonia salts had been proved by Lawes. The history of the production is linked with some of the famous names of our profession: Solvay, for example.

Bones seem to have been used as a fertilizer from about the middle of the 17th century, but it was not until 1840 that Liebig suggested the treatment of bones with sulphuric acid to increase the availability of the phosphate. Lawes applied this principle to mineral phosphates and obtained a patent in 1842 on the production of superphosphate.

Liebig himself discovered the value of potash as a plant food just about the time (1843) that the potash beds of Germany were discovered. About 1845 Liebig was actually applying mixed chemical manures carrying nitrogen, potash, and phosphate, and on a sterile sandy soil proving his thesis that mineral additions could produce vegetation in increasing quantity from what had been a barren waste north of Berlin. It was only five years later, in 1850, that Dr. P. S. Chappell and William Davidson commenced the experimental mixing of fertilizers in Baltimore. The Davidson name and Baltimore sound familiar to our fertilizer industry. About 1860 we had seven mixing plants in this country.

It is not possible to catalog here the great mass of names familiar to our chemical profession who were associated with this development of artificial plant feeding. It would simply be a repetition of "Who's Who in Chemistry."

Returning for a moment to Malthus, his prediction, that food supply would be the limiting factor in the development of the human race, brings to mind the disturbing statement that Sir William Crookes made in his presidential address to the British Association in 1898. Sir William catalogued the potential areas available for growing wheat and showed that unless something could be done to increase the yield per acre the wheat-eating nations of the world would have to give way to the non-wheat-eating races. It was just about this time that distressing reports came from Chile as to the possible exhaustion of the natural nitrate fields, and Crookes pointed out that it would be necessary for the chemist to attack seriously the problem of making available the inexhaustive store of nitrogen in the atmosphere.

As evidence that the chemist took up the challenge seriously, and without going into the history of it all, I need only mention Eyde, Frank and Caro, Haber and Bosch, and Pauling, as a few of the well-known chemists whose names are linked with the solution of the problem presented by Sir William Crookes in 1898. Within ten years after

his address there were a number of plants recovering atmospheric nitrogen in various parts of the world, and today they are legion. Within two generations we have producing plants capable of meeting twice any ordinary requirement for both technical and agricultural nitrogen and at prices so low that they could not even have been dreamed of in Sir William's day.

With these larger problems out of the way, the agricultural chemist is now concerning himself with refinements. We are finding that elements other than nitrogen, phosphorus, and potash, play a very important part in the growth of crops. Soil deficiency in elements like manganese, zinc, iron, iodine, and sulphur, have interfered seriously with yields in certain parts of the country. Supplying these deficiencies and broadening the areas available for crop production will postpone the fulfillment of Malthus' prediction to an even later date.

The chemist is also studying plant toxins, especially toxins found in those plants which are otherwise suitable for feeding to cattle. The correction of this evil not only avoids wasteful effort on the part of the farmer but also extends the cultivatable area still further. Many of these minor elements and toxins affect plant growth in extremely minute quantity and the problems involved, therefore, are quite complex. The chemist has played an important part in agricultural development during the past 150 years and is by no means finished. No problem of importance in plant nutrition which has been put up to him, has remained long unsolved. In addition, there is that great group of biochemists, and the toxicologists associated with the entomologists, who are protecting and preserving our plants after they have started to grow. Space does not permit giving them even bare mention. If we can avoid political man-handling, I am certain that limitation of food supply has been postponed far into the future. At the present time the big problem is to educate some of the more backward nations to the importance of the chemist in this field so as to raise all standards of living and afford ample room for expansion of population. There is still a large part of the world awaiting the service of the agricultural chemist.

The Contribution of the Chemist to the Heavy Chemicals Industry for the Advancement of Modern Civilization

By N. A. Laury, F.A.I.C.

Calco Chemical Company

THERE has been a striking change in the atmosphere of our large chemical plants in recent years. Many more well-trained men are employed and exact and rigorous control extends much farther than ever before. The wisdom of this course is evident all around. Every useful instrument is adopted to supplement and to check up human attention, and the many applications and dependability of these instruments have resulted in improving uniformity and safety, and avoiding delays. Log sheets of daily and hourly operating records are studied and plotted over long periods so that the future can be planned and difficulties thus anticipated.

The accident record of chemical plants is relatively a blank sheet; lost-time accidents are extremely rare because of the painstaking attention that is given to every possible risk to workmen from the standpoint of atmospheric contamination, the protection of the person with adequate heat and chemical-resistant clothing, goggles, respirators, and masks, and the guarding of equipment.

The recruiting and building up of the technical staff is no longer haphazard. Selected men are tried in various branches of operating, maintenance, construction, sales, and research. They are further taught by means of more or less formal courses in and out of the plant, and eventually they are placed where their talents are used to the best advantage. This procedure minimizes not only maladjustments but also many regrets, and waste of time and effort.

In the main, these advances are due to research and therefore research is more than ever maintained in a determined and calculated manner as a prime essential in the life of the business. This research covers equipment as well as processes, extending to whatever detailed study may be necessary to secure the fundamental technical data required for new designs.

New synthetic materials, glass and alloys, especially the latter, have made possible radical changes in relation to corrosion and have broadened the range of temperature and pressure operations, so that reactions

are now commonly used which, not long ago, were thought of only as remote thermodynamic possibilities.

Modern acid plants are remarkable for their simplicity, efficiency, safety, and appearance, compared to those of a few years ago. All kinds of sludge and waste acids are reworked into prime products. Smelter gases are converted to sulphuric acid by the contact process. The waste heat of ore and sulphur burners is recovered and poison-resisting catalysts are used with considerable economy in maintenance and labor. Synthetic nitric acid plants now produce acid of such strength that it requires no further concentration for many purposes. Many of these plants of American design and fabrication are now in operation or in course of construction in foreign countries. Long-desired solutions of old problems have been found when re-examined under the new and superior methods.

In the manufacture of alkali, there is nothing in the world to compare with the three great new plants of the south. A daily output of a thousand tons is the rule, and the cost is at such a level that the soda ash can be neutralized with synthetic nitric acid to produce nitrate of soda, and fertilize cotton fields at a price which competes with that of the imported natural nitrate. One must look at all the new additions to the list of heavy chemicals as much as at the new methods of making them, to realize the contribution of the chemist to the good life, including, of course, such things as the depression and the return of prosperity. No doubt that in all his ingenious endeavor he was doing his share to bring on overproduction and also, less innocently, did he scramble to get rich by risking his savings. If he did behave no better than those who supplied his raw materials or consumed his product, there is an abundance of evidence to show that he is not only more intent than ever at his task of complying with the many demands of the present but that he is still spying out the promised land by the application of his genius and his science.

The work of the chemist figures prominently among the causes for our improved standard of living and it has contributed largely to the growth of capital, especially where his efforts have been coupled with those of strenuous purposeful money-makers.

All this technical advance has not been confined to industry alone. In agriculture the chemist's talent has increased the efficiency of food production and it can be read into some of the chemical plans of the Tennessee Valley Authority—for one of many examples—that the time

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The Contribution of the Chemist to the Electrical Industry for the Advancement of Modern Civilization

By G. M. J. Mackay, F.A.I.C.

Director of Research, American Cyanamid Co.

THERE has been some complaint during the last few years that scientific discovery and engineering invention have so outstripped our progress in social organization that the situation should be corrected by slowing up scientific effort. It would be just as reasonable to suggest, however, that the catalysts in our chemical reactions should be discarded in order to return to the old "natural" slow and inefficient methods. In fact, such progress as we have made socially seems to have been forced upon us by the catalytic effect of the changing conditions in our environment and the tools placed at our disposal by the discoveries and inventions of individuals.

Social progress depends upon the agreement of a large proportion of the population to strive for a given objective. Necessarily it is a slow process to persuade a group with diverse outlooks and desires to reach a common understanding. Discovery and invention, on the other hand, are primarily the result of an individual's active curiosity or his desire to assemble known tools and methods in a new combination. The result of group action is usually an attempt to satisfy the majority with a mediocre compromise which will not too much disturb tradition, while the efforts of an individual are not so inhibited. While the rate of social reaction may be so slow that painful periods of readjustment are required, yet life eventually becomes more interesting for the great majority of the people.

The electrical industry is one of our youngest, and as such, it is a particularly good example of the length of time which is required for the accumulation of discoveries and the acquisition of knowledge before these can be correlated and integrated into useful service for society. The first public electric supply station was established in Pearl Street, New York, in 1881, only 64 years ago, in order to supply energy for the incandescent lamps introduced by Edison in 1879. This event, however, was the culmination of three centuries of scientific observation and experiment. Gilbert's great treatise *On the Magnet, Magnetic Bodies and the Great Magnet, the Earth*, published in 1600, marked the beginning of this period. Though Gilbert left no writings on purely chemical sub-

jects, he was deeply devoted to that branch of science, "attaining to great exactness therein," according to his contemporaries. Robert Boyle, the chemist, added many new facts, and knowledge began to grow through the experimentation of a growing number of observers. One hundred and fifty years later our own Franklin made his famous kite experiment and used electrical effects from the clouds to produce the same results as those from man-made machines. In the early part of the nineteenth century, Oersted, Joseph Henry, Ampere, and Faraday made the observations which eventually led to the construction of the modern electric generator, telephone, and telegraph. In the meantime, Galvani, Volta, Watt and Cavendish, Sir Humphrey Davy, and Robert Hare were laying the foundation for the development of electrochemistry. Toward the end of the century Lord Kelvin, Clerk Maxwell, Helmholtz, and Hertz, by their theoretical and experimental work, and Sir J. J. Thomson, by his discovery of the electron in 1897, were providing the basis for the radio industry.

The growth of the electrical industry during the last 65 years has been primarily in the utilization of already existing knowledge and the invention of new combinations. However, during the last 30 years the larger organizations, such as the General Electric Company and the American Telephone and Telegraph Company, have set the stage for making their own scientific discoveries, and for acquiring new information. This naturally led to an acceleration in the rate of translation of scientific discovery into practical applications.

A casual observation of history would indicate that the pioneers in electrical discovery were physicists. The old term "natural philosopher," however, seems more appropriate. They were men who worked to satisfy their insatiable curiosity in order to get a better understanding of the behavior of the world about them—and who were not limited by conventional definitions of their field. It is interesting that the General Electric Research Laboratory for the first decade of its existence was staffed entirely by chemists.

Consider what the electrical industry would be without the chemical discoveries of the past. The basic materials which made progress possible were: iron, because of its magnetic properties; copper, because of its conductivity; and glass, porcelain, and organic materials because of their insulating characteristics. Though iron and copper were discovered probably 5,000 years ago, surely the original smelter of iron must have been a pretty good chemist for his day. The early Egyptian glass and pottery makers should also be classed as rather good ceramic-chemists, in view of their opportunities.

At the beginning of this century the electrical industry was a healthy, growing infant; but, at that time, materials were, in the main, used only in their already existing forms. Since then, however, countless chemical developments have decreased the cost of generating machinery and other apparatus, increased their efficiency, and made applications of electricity possible in fields then unforeseen. Thus, improvements in the magnetic properties of iron, accomplished by a chemical study of its alloys, had far-reaching effects not only in the industries of equipment and power distribution, but also in communication. The effect of impurities in copper was studied, means for their elimination devised, and consequently the energy losses caused by low conductivity were avoided. Other materials have been made available. In 1886, the American chemist, C. M. Hale, developed the modern process for making aluminum which, weight for weight, has twice the conductivity of copper. This proved so advantageous for overhead transmission that in 1926, 150,000 miles of aluminum cable were in service. Quite recently one of our manufacturing companies, the Dow Chemical Company, installed a short transmission line of metallic sodium, which is correspondingly better than aluminum.

Count Rumford's *Enquiry Concerning the Source of Heat Which Is Excited by Friction*, presented in 1798, started the modern line of thought which has culminated in the steam turbine. New alloys have been developed enabling the use of higher temperatures and pressures, and recently mercury vapor has been substituted for steam as the motive power. In 1919, the average consumption of coal per kilowatt-hour was 3.2 lbs.; by 1934 it had decreased to 1.45 lbs. At the efficiency of 1919 and with the present national load, the total annual coal consumption would be increased by 40,000,000 tons.

In the field of insulation, the transmission voltage on underground cable has been increased many fold, with correspondingly decreased losses since the time of Edison's 220 volt pitch-filled boxes. When it is remembered that the investment in a distribution system is comparable with that in the central station, the importance of improvements in the former is evident. These improvements have been largely the result of chemical study of the materials used. In high tension cable, the use of improved petroleum oils, and better paper, coupled with prevention of deterioration during fabrication, and the elimination of voids in which internal corona could occur, has enabled the distribution of power at 132,000 volts. Better understanding of the chemistry of rubber and the use of anti-oxidants and accelerators have also improved the insulation of low voltage cable.

The use of synthetic materials, such as those produced by chlorination of diphenyl, benzene, and naphthalene for electrical insulation and dielectrics, illustrates a trend in which chemistry will be still more important. Synthetic varnishes of the glycerol phthalate type are displacing the old oil and natural gum combinations, and the enormous consumption of phenol formaldehyde resins in the electrical art is an outstanding example of how rapidly a new material can find useful application.

American chemists have also greatly contributed to the adaptation of glass to electrical applications. Modification of the temperature coefficients of expansion by varying the chemical composition, coupled with simultaneous development of special alloys, has eliminated the use of platinum as a leading-in wire, or for insulating junctions, and made possible the manufacture of glass apparatus for power tubes which would have been out of the question if platinum alone had been necessary. More heat resistant glasses have been developed, and glasses that transmit desired portions of the radiant spectrum from infra-red to ultraviolet have been made. The importance of glass in the industry is indicated by the number of lamps—commercial, residential, and miniature—manufactured in this country which, during 1930, was 487,750,000.

A good illustration of the return in comfort, convenience, and economic well-being, produced by expenditure in research, is the development of the incandescent lamp. Furthermore, the entire history is primarily chemical and the later improvements are almost entirely of American origin. The present gas-filled tungsten lamp is the result of many discoveries and inventions, the more important being:

(1) Discovery of tungstic acid by Scheele in 1781, and of metallic tungsten by the d'Elhujar brothers in 1783.
(2) Discovery by Sir Humphrey Davy in 1802 that platinum could be rendered incandescent by electric current.
(3) Invention of a successful incandescent lamp by Edison in 1879.
(4) Discovery of argon by Lord Rayleigh and Sir William Ramsay in 1894.

Pioneers in the field of industrial research, such as Whitney, Coolidge, and Langmuir, then produced the present highly efficient modern lamp. Involved in the process was much chemistry, including the chemistry of the glass container; the study of special alloys for leading-in wires; the chemical effect of traces of foreign gases; the separation and purification of argon; the effect of small additions of other metals and oxides to the tungsten filament; and the rapid attainment and maintenance of a

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The Industrial Contribution of the Chemist to the Dye Industry for the Advancement of Modern Civilization

By C. G. Derick

Consulting Chemist, Sewaren, N. J.

IT is not surprising that a nation, settled by those daring spirits which left the security of their homelands with the purpose of living the life that their conscience dictated, should be found in the forefront of technical development even in its earliest history.

It is not surprising that the dye industry should have been one of the earliest industries to be developed in the colonies that later became our United States. Land was needed to grow the plants from which these dyes were extracted. And where could more land be found at the price of a few trinkets than in this new world?

The important lesson for us is that from its very earliest history the economic value of dyes was recognized in this present United States.

Since other crops were found to be more profitable, the growing of dyes never became a dominant industry. But enough were continually grown to keep alive in the minds of these people in the new land the economic value of the industry.

When Couper and Kekulé startled the scientific world with their kinetic whirl of atoms held in definite forms by atomic linkages, this country was sufficiently dye conscious to apply this atomic dance to the understanding of the workings of nature in the cultivated field.

If these natural products owe their peculiar properties not only to the kind of atoms present in the molecule, but their position and sequence of linkages, why not make them in the chemical factories and gain greater uniformity of properties, thus eliminating the seasonal variations of agriculture. Thus chemists' minds were stirred with a new vision about 1860, resulting in our present synthetic dye industry.

True, the early unravelling of the atomic linkage structures of many of these natural products was largely done in European centers. But this country furnishes its share of those patient investigators who did the spade work under these European leaders.

But by those queer turns of nature the situation was very different in commercial development of dyes in the United States.

From the moment that Perkins made his celebrated synthetic dye, *mauve*, the synthetic dye industry burst forth in the United States as well

as in Europe. Initially our dye industry was not handicapped through a lack of raw materials and intermediates as was true from 1890 to 1914. Its only handicap originally was a lack of educational institutions to produce a sufficient number of trained chemists to carry on and enlarge the constantly expanding vista of color. This was a difficulty about which leading English dye manufacturers expressed much doubt even as late as 1918, but it was most happily removed in the expanding of scientific training in our institutions of learning from 1900 to date. Too little emphasis has been placed upon the lack of American trained dye chemists in the development of the dye industry and too much upon the influence of the tariff. The record of the present period of chemical industry in the United States is ample proof that sufficient numbers of American trained chemists will overcome any technical and economic difficulty, including the tariff.

In the early sixties, Dr. August Partz, a German chemist, erected a plant for magenta on Long Island. He was to import "half products" from Germany, but it is doubtful if the plant really operated. Its importance is that the United States was from the very start considered a logical location for the synthetic dye industry.

Further confirmation of the economic desirability of the United States for the manufacture of synthetic dyes is seen in the incorporation of The Albany Aniline and Chemical Works, on April 7, 1868, by Mr. Arthur Bott and his associates at the repeated suggestion of Professor A. W. Hofmann. Mr. Bott was engaged in the manufacture of colored paper and cardboard at the time. And it is a significant fact that our industry initially developed dyes for paper and ever since in this field has remained fairly independent of the rest of the world.

The Albany Aniline and Chemical Works was initially successful only in the manufacture of fuchsine. Soon it was reorganized and lost its distinctly American character when Bayer and Company apparently took over the Bott interest. The dominance of the German interest in this concern remained until the World War. Here Ellwood Hendrick got his early dyestuff experience.

The activities of Dr. Partz introduces a typical American character into the industry, Dr. Victor G. Bloede, trained at the Brooklyn Institute, who first engaged in the manufacture of inorganic salts used in the textile industry. Under the firm name of Bloede and Rathbone about 1875, a start in the production of synthetic dyes was made at Parkersburg, W. Va. Their raw materials were the same as those in use in Europe, the "light oils" of coal tar gathered in lots of five to fifty barrels according to the size of the various coal tar distilleries and gas plants

scattered over the United States. From this heterogeneous supply the desired fractions were cut by distillation in an old boiler shell without a column and fuchsine and alkali blue manufacture was attempted.

But the purity of the desired fractions left much to be desired and resulted in the introduction of the picturesque and brilliant character, Mr. James A. Moffett of Standard Oil fame, into the dye industry and the formation of the American Aniline Works. His skill in the art of distillation soon solved the problem and fractions suitable for nitration were available.

Moffett immediately struck a key-note in the dye industry which was typically American. In Europe nitration was performed in heavy cast iron nitrators on 100 kilos of benzol. Moffett—nothing daunted—used from the scrap pile of the Standard Oil Company an old boiler shell holding 1,000 gallons of benzol, agitated with a center shaft carrying horizontal paddles and cooled with spring water jets against the outer shell. Against remonstrance, Moffett replied that he did not propose to carry out the German plan of "killing flies with crowbars." And he succeeded in manufacturing about 8,000 pounds of nitrobenzol in a single operation. This marks another distinct characteristic of the American production of chemicals of the dye industry so highly developed recently by the Calco Chemical Company. Next with the aid of a large cast-iron water main, the nitrobenzol was reduced to aniline.

Since the original plan was to create a reserve from the sales of aniline oil with which to enter the more profitable field of colors, domestic customers were sought. But only one was found—the Schoellkopf Company at Buffalo, New York, which organization could set its own price. Accordingly, the decision was made to manufacture their own dyes. But no member of the organization possessed the necessary knowledge and experience and attempts to import a personnel from Germany resulted in a warning that any member of the American Aniline Works entering Germany would receive a life sentence.

So this resourceful group were left with the alternative of rediscovering their own methods for the production of magenta and other colors.

This fact is reminiscent of a much later development of the American dye industry, and how well we all know the cost!

American Aniline Works produced about 120,000 pounds of aniline oil and 20,000 pounds of fuchsine before the little Kanawha River went on a rampage and swept the entire plant with its tons of fuchsine melt and liquors into the Ohio River, tinting the river a "beautiful raspberry shade for many miles much to the amazement of the natives along the river shore."

During the first period of the American synthetic dye industry from 1850 to 1884, a number of other firms operated but few lasted until our time. Another company deserving much credit for its accomplishment originated in this early period, Heller and Merz of Newark, New Jersey. The company followed the typical American development and catered mainly to the paint, paper, and leather industries, establishing a reputation for excellency rarely met with in industry. It was making about 25% of the American production of dyes in 1913.

Another personality has left his imprint firmly established in the American dye industry. A member of the American Chemical Society from 1877 and connected with the domestic dye industry since 1882, George A. Prochazka has left for posterity his keen analysis of our industry in his own words.

"Without intention to minimize what has been done before 1882, this analysis will show that a real, conscious, self-contained industry dates from then on—that there had been steady progress for the American dyestuff industry from then until the outbreak of the European War. The logic of events, had there been no European War, would have led to the elimination of existing obstacles and the ultimate creation of a satisfying self-contained American dyestuff industry. The development in that case would have been in a better sense of proportion, more harmonious, more in line with sound economic maxims, and less hysterical and passionate than under the jerk of a world catastrophe."

Together with his brother (ultimately as The Central Dyestuff and Chemical Company) they developed successful manufacturing processes for fuchsine, patent phosphine eosin (1881), its chlorine derivatives (1885–6), its brom derivatives (1890), and in the course of time its iodine derivatives, paper blues, negrosine, and many azo dyes and intermediates.

"All our factory processes, from 1882 to date, were based entirely on facts of common knowledge, accessible to everybody. The information available was generally meager, far from satisfactory for our purposes, and very often misleading. The results were obtained by the most intimate study of the materials used, the reactions involved, the products that it was desired to obtain, with all their chemical and physical constants. The advantage of this mode of procedure was that it led to most precise thinking and experimentation, and finally the gratifying feeling that the processes and products had become conscious ones with which we were thoroughly familiar. There came the certainty that the work had been exhaustive."

And this is the correct economic formula for the technical develop-

ment of a successful dye industry!

"American manufactures of dyes appealed from the very outset for trade to industries that were typically American, such as paper, paint, varnish, furniture, leather, leather dressings, and polishes. Great and proper credit should be given to them for the skill, patience, and perseverance shown in the intelligent study and solution of the various dye problems of these industries. Much inspiration in these lines that have been obtained by foreign manufacturers, on analysis, will be found to be directly traceable to the pioneer work of American manufacturers."

And this is the correct economic formula for the sales development of a successful dye industry!

And now let us apply Dr. Prochazka's criteria to the most conspicuously successful American dyestuff company of pre-world war origin.

Picture a German youth playing in that portion of South Germany where successful synthetic dye plants were rapidly developing. He leaves his native land and comes to Buffalo, New York, as a young man and engages in the leather business. But soon his vision and ability win great success in many lines. He acquires the flour mills at Niagara Falls and in 1877 the franchise and property of the Hydraulic Power Company and undertakes the first development of electrical power at that point.

At this time he is also president of one of Buffalo's gas companies. The duty on coal tar dyes is now 35% *ad valorem* and 50¢ per pound *specific*. His oldest son, J. F. Schoellkopf, returns from Germany, a trained chemist. A dream of his youth comes to realization when in 1879 he incorporates The Schoellkopf Aniline and Chemical Company. A year or two later a second son, C. P. Hugo, also trained as a chemist in Germany, joins the corporation. Soon a million dollars is invested in the business down on Buffalo Creek.

Initially the company must produce coal tar distillates in order to make aniline for fuchsine. But immediately differences characterize the development of this concern. Chemists are something more than glorified plant operators in the dye industry. Their value lies primarily in their ability to vision and create new groupings of atoms to meet new economic needs. Accordingly, the greater the number of such visioned chemists an organization can support, the greater will be its development. Just enough chemists to supervise production means business stagnation and ultimate bankruptcy.

But this organization did not stagnate or enter bankruptcy. It employed two to three times the number of chemists required for supervision of production. Each chemist was given time and urged to create.

Gradually, the organization became familiar with the technical pro-

duction of coal tar distillates, aromatic nitro and amino and sulfo compounds, fuchsine and alkali blues, nigrosines, etc. For at this time the only purchasable raw material was the "light oils" already discussed, and a single firm must proceed over the long path of chemical changes from crudes to finished dyes.

Almost before this lusty child had learned to creep, economically, Germany discovered the advantage of securing an exclusive market in the United States through their patents which would enable them to sell at high prices here, although continuing the manufacture in Germany.

With singular coincidence, the United States tariff for the dye industry was decreased in 1884 from 35% per pound *ad valorem* and 50¢ per pound *specific* on dyes to 35% *ad valorem*. A 20% *ad valorem* was placed on intermediates. The nine or ten factories then in existence became, within one year, four, and these four would have gladly followed the others but had invested large sums of money in plants.

This situation left the Schoellkopf concern with a single alternative—create their own products and processes and receive patent protection whenever possible. Between 1884 and 1903, sixteen patents were secured. Dr. Mensching in 1885 patented for the Schoellkopf Works acids which were quite important in the dye industry of this period and the Schoellkopf organization received royalties from their competitors.

But this situation just focused the fight. Germany endeavored to surround this active American competitor with a patent monopoly. Attacking their meager line with the full German line of products, they drove the Schoellkopfs from one field of dyestuff activity to another so that $100,000.00 per year, additional capital, went into the business for a period of 15 years.

In 1895, the wealth of investment was producing sufficiently to carry the business in spite of every attack of the foreign concerns. Under their chief chemist, Dr. Koehler, the following lines were manufactured:

Basic Dyes	Acid Dyes
Fuchsines	Ponceaus
Safranines	Scarlets
Methyl Violet	Soluble Blues
Chrysoidine	Cotton Blues
Phosphine	Alkali Blues
Bismark Brown	Acid Yellow
	Brilliant Orange
	Eosines
	Fast Brown
	Orange A
	Orange R
	Nigrosines

As Dr. Prochazka pointed out, a true economic development of the American dye industry must be to serve the typical American industries.

From 1895 to the World War period the Schoellkopf organization steadily expanded in productive research. The culmination for this pre-war period was the discovery and patenting of Erie Direct Blacks by Dr. Muller in 1901. However, these blacks had to be improved by Dr. Richard Taggessel, who was assisted by Drs. Rampacher and Edward Culmann.

About this time that genial, sane productive character, Dr. Richard Taggessel, became chief chemist and enriched the entire field of azo dyes by his skill and perseverance. And from 1900 to the period of the World War additional dyes were rapidly brought into production with expanding technical personnel, so that by 1914 the Schoellkopf organization marketed regularly over 100 types of dyes exclusive of their mixtures.

In this period another change in the technical personnel was taking place, for English and American chemists had joined the staff bringing new viewpoints that were to take the leadership in the World War period particularly under that very able Canadian, Dr. W. J. Stainton, another wizard of the azo-dye field.

This same budding leadership was seen in the development of the pure food dyes under the leadership of W. H. Watkins and A. S. Halland. The same development of this company during the war period was due in no small amount to the honest, able economic views of Williard H. Watkins, leader of the dye-application work.

The firm decision to place the future of the business in the hands of American trained technical men was clearly seen in the early period of the World War by the organization of the research department.

Coordinating with the Schoellkopf Works was a technical sales staff, The National Aniline and Chemical Company, to whom much credit is due. These men had vision. Their leader, I. F. Stone, was ably supported by Ellsworth of Milwaukee, Ware of Chicago, Norton of Boston, Biddle of Hartford, and Jesse Starr of Philadelphia. These men were in the front-line sales trenches against the stupendous German machine. They reflected back to the plant the changing technical demands and by every art of sales service succeeded in turning the dye products into cash until the surplus began to appear. In the lean years these men bought and sold anything on which to make a profit to carry on. The enormous profits of the war period quite overwhelmed them after the meager years which had made up most of their active lives.

We understand with Dr. Prochazka that an American dyestuff industry was permanently established long before the World War; that in

the fifteen years preceding this it had enjoyed a very rapid expansion in spite of being forced to purchase many intermediates from other countries.

We understand that the situation regarding intermediates had suffered a very desirable change a few years before the World War when a large domestic market for aniline, exclusive of the dye industry, had developed. So the decision of the Semet Solvay (Coal Tars), Solvay Process (alkalies), The Barrett Company (Benzols, etc.), and General Chemical Company (Acids) to finance the production of aromatic amines allowed A. B. Mitchell and A. G. Peterkin, Jr., from 1910 to 1913 to bring the domestic aniline production to 2,000,000 pounds yearly.

It is a certainty that these same interests would have immediately brought upon the domestic market nitro and amino toluols, naphthalenes, etc., had no war occurred. And this meant the breaking of the last shackle hindering the complete development of our domestic dye industry. For trained American chemists were now being produced in rapidly increasing numbers to wrestle with the Magician's mess—the patents. Subsequent events guaranteed the chemists' success.

With the American dye industry upon a sound basis and in its most rapid period of expansion, war made it possible for England to deny Germany the freedom of the seas.

Many intermediates in use by this rapidly expanding American dye industry were still imported from Germany. Experience was available in the four long-established American concerns to make any of these intermediates.

But would the war last long enough to warrant the enormous investment required?

While the old-experienced American dye concerns hesitated, ignorant gamblers stepped into the momentary advantage. And what a mess they made of the most orderly line of manufacture. Because a man was said to be a chemist he was ordered to standardize fearful concoctions, called aniline dyes. He did not know the difference between an acid or a basic color so he bravely tinted one with the other, anything to get the shade in solution. Is it any wonder that the American public thought the American dyes were inferior to those of foreign manufacture?

During this period the four established American concerns continued to manufacture to capacity the same high quality of dyes that met the pre-war world standards. In 1915, the Schoellkopf works, enjoying more than 50% of the trained dyestuff personnel of United States, began a campaign of expansion that exceeded all their dreams of the past. This expansion was orderly and scientifically built about the actual ex-

perience of their sales and technical men with the needs of the American market, paramount.

In keeping with the philosophy of the dye industry, so well understood by the Schoellkopfs, now joined by Dr. J. F. Schoellkopf (III) (a doctor of philosophy in chemistry), the most comprehensive research and development organization for the dye industry, yet known to the United States, was launched under the direction of the writer simultaneously with the expansion of the plant. The Schoellkopfs knew no other certain method of guaranteeing the success of this investment and industry to posterity. In too few years these newly American trained dye chemists and engineers were to be suddenly called upon to bear the burden of the errors of certain financial interests and rescue as much as possible of this organization which had so successfully dominated the dye industry during the World War period.

The other three pre-war concerns expanded in a more modest manner, but continued to maintain the high standards of their products.

But new concerns continued to flash in and out of the picture without the least idea of what it was all about.

Naturally such a period in such an industry in a country like ours is bound to produce some new lasting applications of established economic principles. And above all others was that put forward by the Calco Chemical Company. Quickly grasping the mass production principle and seeing an application to the dye industry, Jeffcot soon met with support and insured the success of his ideas by the organization of a comprehensive research and development organization under Dr. M. L. Crossley. The steady growth of the Calco Chemical Company, Inc., from the year of its organization is proof enough of the success of industries insured by research and development.

The other dye concerns of the United States that have survived the economic struggle have added nothing new in principle to the industry. Following the well-blazoned trail of the Schoellkopfs, the Hellers, then Merzs, the Prochazkas, the Bloedes, etc., and applying the power of unlimited finance, some of them have reached most important positions in the industry today. This is particularly true of the duPont Company.

And now that the American dye industry is a world factor and a domestic monopoly, it is gathering under its wing or sending forth as lusty youngsters many associated industries well known to the public. Its continued success depends first upon a sufficient number of American scientific workers, trained by competent universities, and next upon devoting a generous percentage of the gross receipts of the industry to research.

The Contribution of the Chemist to the Varnish Industry for the Advancement of Modern Civilization

By Robert J. Moore, F.A.I.C.

Development Manager, Varnish Division, Bakelite Corporation

INDUSTRY in general during the past twenty years has undergone a revolutionary change fermented by the chemist and his research work. And American Industry has been alert to realize that in the chemist and his work lie the insurance of continued existence. Research has become the deciding factor in the strategy of business life. One of our foremost American investors crystallized this attitude in his statement: "Before investing in a corporation's stock or estimating its future position, I would consider not so much its present financial status nor its past record of earnings, but mainly its fixed attitude toward research."

The Synthetic Kingdom, which the chemist has added to the three we used to study in school—the Animal, Mineral, and Vegetable—has upset the commercial geography we were taught at the same time. Natural products no longer distinguish geographical locations. The indigo-plant of India, the rubber tree of Brazil, camphor in Formosa, the silkworm of China, like saltpeter from Chile and varnish resins from New Zealand, all have lost their specific geographical relation in the test tubes and retorts of the chemist. Even the cotton plant of Mississippi is being hard pushed by the wood pulp of Sweden. And cotton does not know before it is all ginned whether it is going to be a tub of lard, a bottle of salad oil, a stick of dynamite, a pair of silk stockings, the skin of a sausage, or the coating of an automobile!

Natural products are being displaced by improved synthetic products; old industries are daily meeting dangerous rivals hatched in the fertile mind of the scientist. The ice manufacturer, bristling at electric refrigerators for the home, suddenly finds himself confronted with solid carbon dioxide competing for his shipping and distribution markets. The wood distillation industry for years placid in its intrenched position and earnings suddenly is faced with pure methanol and acetone made from the gases, carbon monoxide and hydrogen. The reader is no doubt familiar with case after case of similar instances of the competition of research. And many references could be cited to unprogressive

industries—oblivious to the need for research—suddenly awaking to find their process obsolete or their products displaced.

The varnish industry is a good example of this synthetic revolution. During the past twenty years, and especially during the last ten years, it has changed from an art, centuries old and buried deep in mysteries and secrets, into a laboratory-controlled chemical industry. Its raw materials, its methods, and its competition for markets have changed. And because of his contribution and strategic position with respect to these developments the importance of the chemist in the industry has become dominant. During the period when varnish-making was an art, salesmanship was its "science," and the chemist, if there happened to be one in the company, was used largely to lend a touch of prestige or to analyze the fuel and other raw materials. Today, the manufacturer realizes that his laboratory is his ability to meet the changing conditions and demands of his markets—his assurance that his products will meet the quality competition of tomorrow. His reliance has shifted from dependence on mere salesmanship to the research and development of his chemists and technologists. His laboratory has changed the pace of the industry—given it new life, new values and broadened its fields.

From early times, as far back as the ancient Egyptians, until recent years the making of varnishes remained practically unchanged. A varnish contained essentially the following ingredients: a drying oil such as linseed obtained from flax seed or in more recent years tung oil pressed from the nuts of the tung tree of China; a fossil resin such as kauri from New Zealand, copals from East India, Africa, or South America, or rosin from the yellow pine tree of our country. Catalytic driers such as litharge or umber were cooked into the oil and finally turpentine or petroleum distillates were used to reduce the viscosity for use.

Looking back in history we find that the early Egyptians used fossil resins in linseed oil. The protective coatings on their sarcophagæ have been examined and point to such formulations. Both Pliny and Discorides describe drying oils and resins dissolved in them. Galen in the second century A. D. mentions the use of lead and umber to speed the drying of oils. Theophilus Presbyter (10th–11th Century A. D.) described varnish making much like the 19th century varnishes, but he used his varnishes molten without liquid thinners. In 1520 rosin was mixed with Sandarach gum and "run" in linseed oil. This was applied hot as a coating for cross-bows, armour, etc.

Let us compare these early coatings with the varnishes of the years 1910–1920. In this later period the oils were largely linseed and some

tung. These dried to a flexible film largely by oxidation. To give them luster and hardness a fossil resin was incorporated. There were dozens of such resins available ranging in hardness and brilliance from Zanzibar Copal or Kauri, down through Manila, Congo, East India, Demerara, Pontianak, Sierra Leone and Damar. These resins had to be made compatible with oils by first "running." That is, by placing in the varnish kettle and destructively heating to about 690° F., driving off as volatile matter about 25% by weight, in the course of which treatment the pale resin became very dark. The oil was then added to it and "driers" such as litharge, or the salts, resinates or linoleates of lead, manganese, and cobalt were cooked in. After the desired viscosity or "body" was obtained by cooking, the varnish was thinned down to usable consistency with turpentine or mineral spirits. A certain amount of rosin and rosin esterified with glycerine was also used as a cheaper resin in place of fossil resins.

Varnishes varied from elastic or "long" varnishes containing small amounts of resins to brittle, hard or so-called "short" varnishes containing relatively large amounts of resins. The "longer" varnishes used as spar or exterior finishing varnishes were more durable while the shorter varnishes were used as interior trim or furniture varnishes and had relatively little durability. The five main classes of varnishes made, together with their "length," that is, pounds of resin per gallon oil, relative exterior durability and drying time are given in the following table:

Type of Varnish	Length (lbs. resin per gal. oil) (Approximate)	Relative Durability in Weeks*	Relative Drying Time in Hours: Dry to Touch	Relative Drying Time in Hours: Hard to Re-coat
Finishing (for autos or railways, etc.)	1½–2	50	10	48–72
Spars	2–3	32	4	30
Floor	4	8	4	24
Interior Trim	5–7	4	4	36
Furniture	8–12	1	3	24–48

* This is a somewhat accelerated test made by exposing the varnish over steel panels on the roof at an angle of 45° to the sun facing south, in New York state.

Aside from the relatively poor durability of these coatings, their slow drying was a constant source of dissatisfaction. This criticism was particularly acute in the automobile industry where the finishing of the car was the narrow neck in the production bottle. As examples let us cite the finishing schedules used by a prominent automobile manufacturer. Back in 1913 in took six weeks to apply the 22 distinct coats, 11 coats

of primers, surfacers, rough-stuff and glaze, 4 to 6 color coats, 2 coats of rubbing varnish and 1 coat of finishing varnish. In 1920 it took from $1^1/_2$ weeks to 3 weeks on auto production. A typical finishing schedule of the latter period would be as follows:

1 coat primer	Air dry	24 to 36 hrs.
1st coat surfacer	Air dry	24 hrs.
2nd coat surfacer	Air dry	24 hrs.
1 coat glazing putty	Air dry	24 hrs.
Wet sand and dry		
1st color coat	Air dry	24 hrs.
2nd color coat	Air dry	24 hrs.
Wet sand and dry		
1st coat colored rubbing varnish	Dry	24 to 36 hrs.
2nd coat rubbing varnish	Dry	24 to 36 hrs.
Rub and stripe		
Final coat finishing varnish	Dry	48 hrs.

Due to the demand for speed in the finishing of autos, and because of discoveries made during the war, there appeared about 1923 the nitrocellulose lacquer coating. This type of coating was, of course, a chemical contribution made possible by the preparation of low-viscosity nitrocellulose and by the building up during the war of a new type of fermentation of corn which yielded the necessary solvent butyl alcohol and, by esterification, butyl acetate. A nitrocellulose lacquer does not dry by slow oxidation but by the evaporation of the volatile solvents. This evaporation leaves a hard film of nitrocellulose. This is, by itself, too brittle and must be plasticized by materials which will remain in the film, such as dibutyl phthalate, tricresyl phosphate, etc., typical chemical products. Also, to give better adhesion, body, and luster a resin must be added. From 1923 to about 1928 these resins were mainly damar and esterified rosin. Such a lacquer when clear is not more durable than the old clear varnish, but when pigmented with zinc oxide and other pigments opaque to ultra-violet light the durability is much increased. Three coats of pigmented lacquer may be placed on an auto allowing only 15 to 30 minutes between coats and these were used to replace the color coats, rubbing and finishing varnishes of the old system. Of course, the lacquers dried with a poor luster and had to be rubbed down to a smooth finish with wet sandpaper and polished with oil and rotten stone or other polishing agents to a satisfactory luster.

The saving in time was large enough, however, and the durability great enough to sweep varnishes practically entirely out of the auto industry within four years. Other industrial uses of lacquers quickly

developed and finally it appeared in modified form as a brushing lacquer for use in the home.

This challenge to the varnish industry taxed its resources to the utmost and was met by two distinct phases of work. The varnish manufacturer turned to his chemist and became a lacquer manufacturer. He plunged into new types of raw materials, new types of equipment, and utilized his knowledge of basic finishing methods and schedules. At the same time, however, the chemists went to work to make their varnishes quicker drying and more durable. New resins were discovered which achieved drying of oil coatings largely by polymerization instead of oxidation and the modern "quick drying" varnish and enamel resulted.

These first synthetic resins were phenol-formaldehyde combinations dispersed in rosin or esterified rosin. Their principal contribution was speeding drying to about four hours with a slight increase in durability. Then followed later the straight phenol-formaldehyde resin of today which, without modification by rosin or other agents, is oil-soluble and which revolutionized conceptions of oil length and durability. These offered the varnish manufacturer entirely new standards of durability and chemical resistance. They quickly displaced natural resins and slow drying schedules in many uses and opened up entirely new fields for the products of the paint and varnish industry. At the same time other types of synthetic resins were appearing, based on combinations of phthalic anhydride and glycerine. These likewise increased the durability of nitrocellulose lacquers by displacing all or part of the natural resins and found their way into various types of baking and more recently air-drying finishes.

Today the varnish chemist has at his disposal a complete and entirely new group of raw materials, all products of chemical industry. Instead of selections available from various types of fossil resins he has hundreds of synthetic resins of the phenolic and alkyd types. In addition he is offered the specific qualities of other combinations, including vinyls, cumarones, diphenyls, and many others. Formerly his drying oil was the basis of his durability. Today his synthetic resins have greater integrity on exposure than his oils and he can use combinations to give almost any range of drying speed.

The original choice of mineral spirits or turpentine has broadened to a widely diverse selection of closely fractionated and highly refined petroleum distillates, hydrogenated hydrocarbons, dipentine and related products, and a wide range of synthetic ethers, esters, and alcohols.

In the field of pigments alone the formulator of 10 or 20 years ago,

(*Please turn to page 202*)

The Contribution of the Chemist to the Leather Industry for the Advancement of Modern Civilization

By Allen Rogers, F.A.I.C.

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IN New York City, during the week of April 22 to 26, 1935, there is to be celebrated the 300th anniversary of the founding of the American Chemical Industry. The date of 1635 is thus set when the first chemical products were made in this country. It is certainly a most worthy commemoration; but, as a matter of fact, one branch of chemical industry, the manufacture of leather, was established even before that date. The first tannery in this country was probably in the settlement of Virginia, but no definite records are available. Experience Mitchell, a tanner, came to Plymouth in the ship *Ann* in 1623. Francis Ingalls, another tanner, settled in Lynn in 1630. Philman Dickerson was granted leave to make "tan pitts" in Salem in 1630. By 1650 there were 51 tanneries in Massachusetts Bay Colony. In 1630 Francis Higginson, minister at Salem Settlement, wrote to England telling of great increase in cattle, sheep, and goats, and also mentioned sumac and other trees good for tanning and dyeing leather.

To go into the history and developments in leather manufacture would consume more space than can be given to this article. In passing, however, it may not be out of place to indicate that the leather industry is the oldest on record. In Genesis III—21 we find "That unto Adam also and his wife did the Lord God make coats of skins and clothed them." We read of Simon the tanner, at the time of Christ, and even then tanning was an old established art. In Exodus we read of rams' skins dyed red, showing that leather was not only made but also colored.

The early people of India, Egypt, and Arabia made leather by tanning with roots and barks. In the British Museum are pieces of leather at least 3,000 years old. The Chinese tanned leather with a mud containing salts of alum. The Moors learned to tan leather from the Egyptians. During their conquest of Spain, the Moors set up tanneries in that country, the product being known as Morocco leather. English traders who imported Morocco leather called it Spanish leather, and started later to make it in England. When the Pilgrims came to America they brought the process of leather manufacture with them and established tanneries in New England as already indicated.

Although we point to the Pilgrim Fathers as having established the first tanneries in America, as a matter of fact the Indians were the first American tanners and leather chemists. They were very skillful in making leather which they used for shirts, trousers, and moccasins; and they built even their wigwams of leather. The methods of the American Indian were crude, but produced the results desired. After killing the deer or buffalo with his stone axe or arrow he would remove the hide with his bone knife, wash it in running water and then expose it to the rain and sun until a certain amount of decomposition had taken place—or what we have come to call the process of sweating. The hair, which was loosened through this putrefaction, was removed with a knife or sharp stone and the skin was rubbed over with dust from the stump of a rotten tree. He would then rub in the fat and brains of the animal, thereby making a soft and waterproof leather. They did not worry about the hydrogen-ion concentration or the pH of the chemicals.

It was no doubt noticed early that wood smoke had an antiseptic and preservative effect on skins which were dried in it, because this method was used by the American Indian as well as by more civilized leather manufacturers. Where did the Indian gain his knowledge? This is another story.

Following these primitive methods of oil and smoke tannage we come to the application of alum. The dyeing of leather led to the discovery of numerous vegetable tanning materials. It has remained, however, for the last three-quarters of a century to see more done for the advancement of the leather industry than ever before, and in this development the American chemist has played a most important part.

The real outstanding victory for the American chemist came through the introduction of the chrome process for tanning. In 1884 August Schultz, a chemist employed by a Brooklyn dyestuff firm, patented his two-bath chrome process. His invention consisted in treating the skins with a solution of chromic acid, prepared by the action of hydrochloric acid on sodium or potassium dichromate, and afterward with a solution of sodium thiosulphate and hydrochloric acid. As the leather came from the bath it was blue in color, and upon drying became hard and stiff. The American tanners poked fun at the process and thought it was a great joke, but Robert Foerderer, a young tanner in Philadelphia, had an idea that Schultz was right and after many experiments he found that by applying an emulsion of soap and oil to the tanned skins the difficulty from hardness was overcome. The dyeing and finishing were then perfected, the product was put on the market as *Vici-Kid*. And it

soon took the place of heavy bark-tanned leather, such as the cowhide leather of which our grandfather's boots were made.

Martin Dennis, a chemist in Newark, N. J., later perfected a one-bath chrome process for calf and side leather. These two processes have so revolutionized the manufacture of leather that today over ninety-five per cent. of all shoe upper leather is made by the chrome tanning process. This is true not only of America but for the rest of the world as well.

The introduction of chrome tanning acted as a stimulus to the American tanner, and soon practically all of the large concerns established chemical laboratories for control and research work. As a result of the efforts of these chemists the old methods of bark tannage were modified so as to obtain a better product. The time of treatment was reduced from many months to several weeks. Other processes have been developed which require only a few days to produce a very satisfactory grade of sole leather. These very rapid processes, however, have not met with general favor. The old style stiff and squeaky sole leather has been replaced by a firm and compact product with increased wearing quality. The methods used for soaking, unhairing, bating, and pickling hides and skins have been given consideration by the leather chemist and many improvements have been introduced. The study of enzymes has led to the elimination of the old unsanitary and dangerous manure drench. New types of vegetable tanning materials and various combinations have resulted in certain desirable characteristics. New synthetic tanning materials have been developed, and new tanning methods evolved. The finishing of leather has been given considerable attention by the chemist which has resulted in many pleasing effects. A more intimate knowledge of dyestuffs and pigment finishes has had a marked influence on the appearance of modern leather.

The American chemist has developed new kinds of leather to meet the various demands, from the waterproof and long wearing chrome combination shoe sole to the soft washable product used for gloves. He has made possible the utilization of snake and lizard skins for the dainty foot of our lady fair. Our old friend the shark has been made to surrender to the leather chemist. His armor has been pierced by the magic touch of the chemist's wand, and we now find his skin being used for bag and case leather and for the uppers of our youngsters' shoes. The uncracking patent leather as well as the beautiful silky suede are the result of the chemist's activity.

As time marches on we find ourselves returning to the dress of the American Indian for we now again have leather shirts, leather coats, leather hats, and leather trousers.

Last but by no means least, chemists with a knowledge of animal tissues have developed the surgical suture, without which the wonderful achievements of the surgeon would be impossible. The chemist in this field has so perfected the processes that the surgeon now always feels confident that his operation will be a success. He can plan in advance the time required for absorption and the healing of the wound. He knows, too, that through the careful attention of the chemist, there will be no danger from infection.

There is probably no branch of chemical industry in which the chemist has played a more important rôle than in the manufacture of leather. The results of his endeavors have contributed to the health, comfort, and security of mankind. As a child he is restrained by the leather strap. During his life he is shod with leather. He is clothed with leather. He protects his hands with leather. He drives his horse with a leather harness. He carries his money in a leather purse. He travels with a leather bag. He eats his meals while seated in a leather bottom chair. He holds up his trousers with a leather belt. His books have a leather binding. When he has the pleasure of a surgical operation he is sewed up with leather. When he passes to the great unknown his earthly remains are embalmed with a formaldehyde tannage.

Contribution of the Chemist to Printing Ink Industry

(*Continued from page 132*)

1895. Lithographic, and eventually offset printing, was born in Senefelder's discovery in 1796. All of these inventors and subsequent developments involved the use and understanding of chemistry. In fact, physico-chemistry plays so important a part in the actual lithographic process that it is called "Chemical Printing" by some persons.

It should be evident from the foregoing that the chemist has certainly contributed his share in the technological development of the printing ink and graphic arts industry. In turn, these industries have and will continue to function in the promotion of knowledge, education, and literature destined to reach the entire habitable globe. The introduction of chemical science and the chemist as an individual into these important industries has in the past, not only proven of inestimable value to these industries and to mankind, but will also in the future, prove of even greater value through the present cooperative intelligent investigation which we call research.

The Contribution of the Chemist to the Glass Industry for the Advancement of Modern Civilization*

By Alexander Silverman, F.A.I.C.

Head, Department of Chemistry, University of Pittsburgh

IT is interesting to know in connection with the celebration of the 300th anniversary of the founding of the American chemical industry that the first industrial enterprise in the American colonies was a glass factory located about a mile from Jamestown in the colony of Virginia in 1607 or 1608. Mention of this is made by Captain John Smith in his "History of Virginia." The factory was engaged in the manufacture of bottles and beads, the latter serving as currency for trade with the Indians. Shortly after the building of the factory, a Captain Newport carried some of its products, probably bottles, in an export shipment to Europe. The significance of glass was already anticipated in an interesting fashion by Dr. Samuel Johnson, when, in an article which he published in England in the latter part of the eighteenth century, he stated:

"Who, when he saw the first sand or ashes by a casual intenseness of heat melted into metallic form, rugged with escrescenses and crowded with impurities, would have imagined that in this shapeless lump lay concealed so many conveniences of life as would in time constitute a great part of the happiness of the world? Thus was the first artificer in glass occupied, though without his own knowledge or expectation. He was facilitating and prolonging the enjoyment of light, enlarging the avenues of science, and conferring the highest and most lasting pleasures; he was enabling the student to contemplate nature and beauty to behold herself."

Let us now consider a few of the contributions of the past 300 years in this field, together with their effects on modern civilization. In 1672, Richard D. Nehou, under the patronage of Louis XIV, operated mirror factories in France. The great "Galleries des Glaces" at Versailles in which the Peace Treaty which concluded the World War was signed was fitted with these mirrors. His son, Lucas, in 1688, invented the plate glass process which until very recently was in operation the world over.

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*Contribution No. 298 from the Chemistry Department, University of Pittsburgh.

Who the chemists were who prepared the raw materials employed in glassmaking at that time is not a matter of record, but it is certain that in 1855, the French chemist, Petitjean, invented the process of depositing silver from a solution in the manufacture of mirrors. This step, together with the invention of plate glass, made the mirror available to the people at large instead of serving as a special privilege to a chosen few who could afford to purchase the old Venetian article. With the advent of soda ash, first by the Le Blanc and later by the Solvay process, and with salt cake, a chemical by-product in acid manufacture, plate glass production has improved constantly. Its utilization today either directly as polished plate or reinforced by wires or chemical plastics is too well known to require elaboration. We know that automobile and other transportation, and the attractive displays in shop windows of our time depend on plate glass whose service to mankind has real significance.

Already in the 12th century, an Anglo-Saxon monk by the name of Theophilus had devised the hand cylinder process for making window glass which remained in use for over six centuries. With the successive advent of mechanical processes, the cylinder process of Lubbers and the sheet processes of Fourcault, Colburn, and others, chemical and physical control proved essential factors. It is impossible to draw window glass with modern machines unless such control is applied perfectly. This has involved the introduction of purer chemicals of the commercial type and in very recent years has been carried even a step farther through the use of special materials for the absorption or transmission of heat rays and ultra-violet rays as the case may be, and according to the purpose for which these special glasses are intended. What window glass means to civilization is obvious in our dependence upon it for protection against the elements in inclement weather. Our factories certainly could not operate during the winter season without this cheap transparent material.

We might consider the fuels for a moment. Prior to 1612, wood was the only fuel employed in glassmaking. Then came the introduction of coal in England, and later, in the 19th century, wood gas and coal gas. Ignoring the heat conservation effected by regenerators and recuperators, and taking into account the effect of products of combustion on the quality of the glass produced in open pots or tanks, due credit must again be given the chemist; *first*, for the development of improved processes for gas generation, and, *second*, and even more important, for his cleaning or purification methods which prevented serious contamination of the glass. The newer developments will eventually result in such perfect chemical control that we shall even

be able to manufacture special glasses, now confined to closed pots, in open tanks of the day or continuous types. The use of natural gas as a fuel unquestionably came about through the encouragement which American chemists gave on the basis of chemical composition and thermal value, and the still more recent introduction of fuel oil was largely the result of their efforts.

In 1720, England gave the world flint or lead-potash glass, desirable from the standpoint of high-refractive index and low resonance for the manufacture of the finer drinking glasses and objets d'art. Potash was still obtained from wood ashes, while red lead and litharge had been prepared by the chemical oxidation of lead. At first, flint glass found a comparatively limited use because it was costly. With the opening of various potash deposits and the development of more economical chemical methods for the preparation of the carbonate, flint glass has become a commodity which practically all may enjoy. We have it not only for our finest tableware, but the exquisite engravings and art works of our time are invariably produced in this type. The art of engraving and therefore our enjoyment of the beautiful came with the introduction of the newer chemicals into glass.

Optical glass had already been made in France in the latter 18th century. The early part of the nineteenth finds England interested in its manufacture. The real developments came, however, in the latter part of the 19th century through the propaganda of a physicist and a chemist. About 1880, when only five chemical elements or their compounds had been employed in the manufacture of this kind of glass, Ernst Abbé wrote an article in which he bemoaned the lack of research in the optical glass field. It was read by a young chemist, Otto Schott, who immediately got in touch with Abbé and asked to become associated with him. In the years that followed, the German government fortunately saw fit to subsidize such investigations, and in the 25 years succeeding the publication of Abbé's original article as many new elements or their compounds were added to the list in optical glassmaking. Dr. Schott, while past eighty now, still visits the old factory in Jena daily. He is the dean of glass chemists of all time. Not only were the investigations of Schott and Abbé fruitful in the field of optical glassmaking, but the old Jena glass was the forerunner of the more modern Pyrex in chemical laboratories. We owe it to these gentlemen that accuracy in thermometers and other temperature and pressure reading instruments can be assured through the selection of glass of proper chemical composition. Their contributions are beyond appraisal. The more recent contributions to optical and scientific glass by Sullivan,

Hostetter, Taylor, Litt'eton, and other associates at Corning, New York, must not be overlooked. During the World War, Dr. Finn of the U. S. Bureau of Standards successfully produced large reflectors for astronomical telescopes. The more recent 200-inch reflector of the Corning group would certainly not have been possible without careful chemical control. It will further inform mankind of the distant worlds of space and carry us millions of light years beyond our present knowledge. The lenses of the microscope have revealed the nature of microorganisms and the structure of materials. Stable glass tubing hermetically sealed preserves the sera and the anti-toxins employed for the prevention and combating of disease. The lenses of the camera and motion picture projector instruct and entertain us.

Bottles have been made for ages, even as far back as the early Egyptian dynasties, but with the advent of the machine developed by Michael Owens and others, the older glasses were no longer suitable. Rapid melting and the stability of the product were essential. Freedom from gas bubbles and other imperfections was important. Strength for the safe storage of highly carbonated beverages was paramount. The chemist's introduction of compounds of aluminum and boron insured greater strength and stability and his knowledge of the function of arsenious oxide in gas elimination solved the seed problem. The work in our Bureau of Standards and in the Geophysical Laboratory on ternary systems and similar work in laboratories in England and Germany resulted in glasses which can be melted perfectly and which are free from solid imperfections. What bottles and jars, which are manufactured at the rate of millions per day, mean to us as safe and attractive containers for foods and beverages is obvious.

With hollow ware, we naturally include the electric lamp bulb. Again, wonderful developments in mechanical production have necessitated the most careful chemical control. Once more we have an object manufactured in millions per day. The newer, inside-frosted bulb is the outcome of a most interesting chemical study of hydrofluoric acid and other etching media. In the manufacture of the bulb, chemical studies on the lead-in wires, the tungsten filament, the chemical go-getters, and the inert gas content are worth mentioning. What could we do without the magic bulb that transforms night into day? And in speaking of bulbs, we must not overlook the less common varieties used in radio transmission and reception and their powerful influence upon us; or the X-ray bulb with the assistance it lends to modern surgery as well as to our studies of the structure of materials and the very chemical nature of solids. X-ray bulbs are ever improving because of

better chemical composition to insure the transmission of the rays; and the operator is protected by the newer chemical glasses which screen him from the injurious effects of the radiations with which he works. Going back for a moment to illuminating glass, we might think of the reflector shades, globes, and bowls, whose chemical composition has again gone through an ever-progressive evolution to insure pleasant illumination and yet light which is efficient and relieves the eye from excessive strain. With the advent of incandescent gases for lighting signs, chemical tubing of special composition has brought about a variety of colors which attractively draw our attention to the purpose of the sign without causing the eyestrain which older methods of advertising involved. Furthermore, some of these beams guide the aviator.

Finally, we devote a little time to the subject of color. A considerable variety has been available since ancient times, but the pleasing ruby of gold came less than three centuries ago, in 1677, through the contribution of Johann Kunckel, even though he may not have known of the colloidal nature, announced much later by Szigmondi. The use of selenium as a coloring agent for red glass was patented in 1865 by J. T. Pelouze, a French chemist, and has found ever-increasing application. Within the last few years, the cooperative researches of physicists and chemists have divulged the real nature of this coloring agent, and it is now possible to introduce the proper compound into the batch and produce the ruby glass without reheating as was formerly necessary. Selenium orange is another product of the last quarter of a century. Manganese dioxide as a decolorizer to overcome the objectionable green color produced by ferrous compounds in glass, has largely given way to selenium. Uranium yellows are certainly a product of the last three centuries and more recently has come the golden yellow of cadmium sulfide. The rare earths have been introduced, including the beautiful pea green yielded by praseodymium compounds and the exquisite dichroic wisteria of neodymium. Alabaster glasses come within the limits of our study, and while opal glasses may have been made more than 300 years ago, the colloidal particles responsible for their opalescence have since been precipitated by salts naturally occurring in the earlier impure alkali and more recently deliberately introduced for precipitation purposes. Whether we consider color from the standpoint of the safety of a signal light or the charm of an artistically attractive object, it does play a part in modern life. Who can deny the delight afforded by our decorative mosaics and art windows? Who has not been awed into reverence when a religious motif was created by an

artist? Only too often we think of color as the product of organic research. The inorganic also has color to its credit for in the Vatican studios in Rome, where artists create the modern master-pieces of mosaic art, an exquisite example of which, the Immaculate Conception of Murillo, reposes in the Catholic Shrine in Washington, there are over fifty thousand color tones in glass.

Surely glass has been indispensable to social well-being in the past three centuries. Our only consolation in having to do without it would lie in the fact that we should not have the mirror to reflect our sorrow.

Contribution of the Chemist to the Sugar Industry

(*Continued from page 116*)

The benefits to the social welfare of humanity, which have resulted from the work of chemists in the field of sugar, may be cited in other instances. The production of dextrose from starch by Kirchof in 1806, previously mentioned, has been improved to such an extent that thousands of tons of pure refined crystals of this sugar are now manufactured each year in the United States and sold to the public at a low cost. While dextrose has only about half the sweetness of sucrose, its superior qualities for certain medical purposes and for special nutritional and commercial requirements have made this sugar not only of great economic importance but of humanistic value as well. The same may be said also of the newer developments in the manufacture of lactose, the sugar designed by nature for feeding the young of humans as of other mammals. The cheap production of pure milk sugar as a constituent of infant foods has undoubtedly saved the lives of many new-born children of invalid mothers. Improvements in the manufacture of malt sugar have also been of great benefit for special nutritional needs. While the rarer sugars, such as mannose, fructose, xylose, arabinose, etc., are not produced in large commercial quantities, the employment of these sugars in making culture media for the identification of pathogenic microorganisms has been of great benefit in diagnosing sickness.

Investigations of chemists upon diseases where sugar is imperfectly metabolized in the human system, and upon accurate methods for determining sugar in the blood and urine of patients, contribute daily to the comfort and welfare of thousands of diabetics.

It is hoped that this brief sketch of the work of sugar chemists in a few fields of agriculture, industry, economics, nutrition, and medicine will convey some idea of the importance of their work in helping to improve the social life and welfare of mankind.

The Contribution of the Chemist to the Paint Industry for the Advancement of Modern Civilization

By LeRoy D. Soff, F.A.I.C.

Chief Chemist, Paragon Paint and Varnish Corporation

THE chemist is a comparative newcomer to the paint industry. Prior to the 20th Century he found it almost impossible to enter a paint factory either by door, window, or chimney. It is only during the present century that the paint industry, awakening to its need of the chemist, has finally opened wide its portal—the front door, to be exact. And in the same breath it must be said that it is only within the same period that people have become to any extent "paint conscious." Today every producer of the ingredients used in paint, and every manufacturer of paint that is really paint, find the services of chemists indispensable.

We are told that the Egyptians used some sort of asphaltum varnish in the preservation of mummies, and our Bible makes reference to Noah's use of pitch in waterproofing the Ark. Moreover we know that centuries ago artists prepared mixtures of pigments and oils. But despite the apparent antiquity of the subject the greatest growth in the paint industry, with its accompanying benefits to society, has occurred during the past few decades of chemical supervision.

An important accomplishment of the paint chemist has been the creation of finishes which are really beautiful. Such beauty is dependent upon two factors—the color of the pigment and the nature of the paint film. In both fields miracles have been performed. To many of us the word paint connotes, primarily, color. A few hundred years ago the pigments available were very few in number, most of them naturally occurring. Accidental discovery was for a long time the only means of adding to the list. But in 1824, owing to the scarcity of lapis lazuli, the natural source of ultramarine blue, the *Société d'Encouragement* in France offered a prize to the inventor of a cheap method of producing the pigment artificially. The prize was won in 1828 by Guimet, a French chemist. Gmelin, a German chemist, also perfected and described a method at about the same time. The artificial process not only permanently relieved the scarcity of the natural blue pigment, but at the same time lowered the cost.

During the hundred-odd years since Guimet received his prize, untold numbers of pigments have been developed by chemists whose names do not appear in the literature. The color range has been widened; the older pigments have been improved in texture, ease of grinding, strength and permanency—all with the result that the paint consumer today may have any color scheme he desires on any article he may name. Where we formerly had only one white pigment, the poisonous white lead, we now have a dozen new types, most of them possessing far greater brilliance and far superior opacity. Supplementing the muddy ochres, siennas, and umbers, we now have a vast range of chemically produced yellows, browns, and oranges. Bright greens, flaming reds, exotic orchids, captivating peaches, and roses—colors which at one time could not be had at any price—these are all in daily use today, made by chemical processes.

The synthesis of new pigments has made possible the application of psychology to the selection of color schemes for our surroundings. It is astonishing how quickly a mood can be produced by means of color. Play rooms are made gay, even bizarre; lounges are restful; hotel lobbies are dignified and imposing; and some of our chop suey houses are truly oriental—all with the aid of paint. Then, too, paint may be made effective in retaining the student's alertness, and in diminishing fatigue among office workers as well as laborers. Color, moreover, is an excellent salesman. It sells toys, implements, furniture and even houses. That is why manufacturers are looking more and more closely into the color appeal of their products and packages. Paint helps.

Color, as it affects light- and heat-reflection, has been the subject of considerable experiment. A particularly important benefit of this work has been in the painting of exposed gasoline storage tanks, resulting in less evaporation and therefore in less loss and a diminished fire risk.

Equalling the color in importance is the film-forming material itself. It must be fluid when applied, but it must soon dry and harden. No doubt we are all familiar with linseed oil. Even with the aid of metallic catalysts, the so-called driers, linseed oil produces rather a soft film for interior use. Yet for years it was the only liquid available for such use. In fact a tradition, sponsored chiefly by advertising and reluctance to change, grew up around the combination of white lead and linseed oil, raw or containing driers.

But the chemist cannot be fettered by tradition, for he is taught to think. Methods of refining linseed oil have been developed. Able chemists have devoted years of study to the chemistry of linseed oil. The polymerizing effect of heat treatment has been investigated.

These and other studies, applied to practice, have furnished oils possessing many desired characteristics such as pale color, improved flow, high gloss, penetration or non-penetration as desired, as well as pigment wetting and better drying properties. But regardless of what is done to it, linseed oil alone is not capable of meeting all of the modern requirements of a paint vehicle.

For years it had been known that many of the fossil resins, properly heat treated, could be blended with linseed oil to yield the base of varnishes which formed very hard films. The drying time, however, was usually very long, and the entire method of manufacture of such varnishes was usually a "father-to-son secret." The advent of China wood oil and of the chemist has helped to solve the drying problem of both paints and varnishes. Heated alone China wood oil turns into a useless jelly; but properly kettled with other materials it forms the basis of excellent, tough, water-resistant varnishes such as have not heretofore been known. Suitably pigmented, as with lithopone, a China wood oil varnish yields one of the newer types of interior paint known as "flat" (dull finish) white. The uniformly dull finish has met with great favor. It is washable, sanitary, and pleasing to the eye.

Along with the progress of China wood oil there has developed a hitherto unexplored field, that of synthetic resins for use in paint and varnish. Whereas a "practical" man was able to experiment with linseed oil or (if he was sufficiently liberal-minded) with China wood oil or any other oil, the field of synthetic resins, on the other hand, is fundamentally chemical. The production and use of these resins have required chemical supervision, and this has been well repaid. Synthetic resins have made phenomenal progress. They have distinguished themselves in two important respects: *First*, by providing a uniformity which the natural resins have never boasted, and *second*, by making possible the production of finishes formerly unknown. The best of the newer types of finishes differ from the old in many ways, and are characterized chiefly by being quick-drying, water- and weather-resistant, acid-proof, alkali-proof, and (of special interest since the repeal of prohibition) alcohol-proof.

In addition to the psychological benefits of the proper color scheme, the chemist has thus made possible new standards of cleanliness and sanitation. Use of the correct paint permits washing of dust, stains, and grime, and, in contrast with glue-bound wall-paper, paint is distinctly sanitary. Particularly in schools and hospitals, as well as in the home, the benefits of paint are inescapable.

Another function of paint, of vital importance, is that of protection.

Exposed to the elements, wood rots and decays; iron rusts; cement, concrete, and stucco admit water and gradually crumble. Without protective films many structures would be extremely short-lived. The chemist has devised special types of paint for the many kinds of building materials, as well as for implements and conveyances exposed to the weather. Ships, too, are painted to hinder the adherence and growth of barnacles and other marine nuisances, the very weight of which can retard the speed of a ship, thus causing wastage of fuel and delays in scheduled journeys.

Paint, by maintaining a protective coating about objects and structures of various materials, makes practical their continued production and use. In this way paint helps to preserve not only the objects and structures themselves, but also the industries which they represent. Then, too, paint, merely by beautifying unsightly surfaces such as plastered walls or beaverboard partitions, has fostered the use of such materials in construction.

Also, paint has made possible the simulation of natural materials where for one reason or another the originals may not be used. For example, the appearance of a column of wood may be duplicated with only a small part of its weight and fire hazard by painting and graining over a cylinder of sheet metal. Marble may be simulated by cleverly painting glass. Travertine is very frequently duplicated in paint.

Stepping beyond the range of ordinary application or imitation of other materials, chemists have developed paints which by reason of their immobility may be fashioned, upon the wall, to produce effects which, entirely apart from the color, are novel and attractive.

Another important contribution of the chemist to this industry and to society has been his studied development of ready-mixed paints and enamels. Paint was at one time a hand-mixed product. White lead was then (and still is) marketed in paste form, to be reduced by the painter as he saw fit, with oil and turpentine and drier. Today there need be no guesswork. Every type of paint conceivable—gloss, flat, eggshell, house paint, floor paint, etc., etc.—is put up in ready mixed form, in containers of practical size. Neither time nor labor need be spent in preparing paint for application. Moreover, careful study has been made to provide easy brushing character stics. This has been particularly noticeable by the layman in the field of the popular quick-drying enamels with which the most inexperienced person may obtain results comparable with those of the master painter.

Manufacturers of articles requiring paint have been greatly benefited

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The Contribution of the Chemist to the Vegetable Oil Industry for the Advancement of Modern Civilization

By H. P. Trevithick, F.A.I.C.

Chief Chemist, New York Produce Exchange

WHILE the development of chemical industries in this country dates back three hundred years to the time of Winthrop, the development of the vegetable oil industry, and particularly of the edible oil and fat industry, dates back only about fifty years.

Previous to that time, the principal edible vegetable oil was virgin olive oil. The production of this oil centered around the Mediterranean, the oil being pressed cheifly from olives grown in Spain, Italy, and Southern France, but also including oil produced in Greece, Syria, Tunis and other countries bordering that sea. The American production is limited to a small quantity grown and pressed in California. The use of this oil in America was promoted by the very large immigration from the southern parts of Europe during the latter part of the 19th century, but even now its use is limited largely to the people of Southern European origin.

The Americans of Northern European stock have always used butter, edible tallow or oleo and lard or other animal products as the source of the fats in the human diet.

Previous to the invention of the cotton gin, the production of cotton was limited, due to the difficulty of separating the seeds from the cotton, but after Whitney made his revolutionary invention, this restriction was removed, and the production of seed cotton increased enormously, particularly in the southern part of the United States. There is half a ton of seed produced to each bale of cotton, and this resulted in the production of much larger quantities of seed than were necessary for planting. However, there was no market for the seeds and they became a nuisance. As this was a waste product, the piles of seed around the gins increased tremendously, and the seed decomposed, causing vile odors and forcing the gin operators to remove the seed. The planters were given as much seed as they would take to be used for fertilizer. The remaining seeds were then dumped in the rivers, damming them and causing many other troubles. Meanwhile, about 1870, one or two mills for crushing cottonseed were opened at Natchez, Mississippi,

and other points, starting the production of cotton oil. By 1880 the number of mills had increased considerably, and by 1900 there were one thousand or eleven hundred mills operating, crushing about four million tons of seed a year. At first the product was used in the soap kettle, but then the method of refining with caustic soda was developed, giving a product of pale yellow color and much better appearance than the crude oil. As there were no means of deodorizing this oil, the taste of even the best grades of the oil was rather unusual, while the off-grades were strongly obnoxious in flavor. As no care was given to keeping the seed sound, only relatively small quantities of good oil were produced in a season, and so the use of the oil was still very much limited. This led to a practice which has had lasting harmful effects upon the demand for cottonseed oil. Since this oil was cheap, it was mixed with lard and the mixture sold as pure lard during the '80's and '90's. When this adulteration became known, the fact that cottonseed oil had been used as a substitute gave it a bad reputation, and the impression prevailed for many years that it was only a substitute and therefore inferior or deleterious. It has taken many years of earnest work to educate the American public to the true facts of the case.

Between 1895 and 1900 the late Dr. David Wesson developed a process of deodorizing oil by the use of live steam. This development has been a tremendous factor in promoting the use of the oil, and has enhanced the value of this material. By this process all taste and odor are removed from the oil, leaving a product which is bland, sweet, and neutral in flavor. The resulting oil has found a ready market as a cooking and salad oil, not only in this country but all over the world, so that during the last thirty years the price of cottonseed oil has advanced from two or three cents a pound to what might be called a normal maximum of 15 to 18 cents a pound, and the extreme maximum of about 30 cents during the war. Naturally the price of the seed has advanced correspondingly, giving the farmers of the South a tremendously increased income from this source.

As cottonseed oil is liquid at about 60° F. ("winter oil" has a much lower melting point) its use as a cooking fat has been greatly limited when compared to lard and other solid fats. But in the early part of the 19th century, another tremendous advance was achieved when the commercial process of hydrogenating all fatty oils was discovered. In this process, hydrogen is added to the unsaturated or liquid part of the fat, which greatly raises the melting point and titre and decreases the iodine value of the oil. Previous to this development, the only way to make hard fats from liquid oils was by mixing the oil with stearine, of

either animal or vegetable origin. Since hydrogenation became commercially practical any nearly neutral oil can be hydrogenated and changed to a hard fat. When this process is carried to completion, a very hard fat is obtained, which has a very high melting point. A small quantity of this material, melted and mixed with any liquid oil, will produce a solid shortening of the desired melting point, suitable for use in baking.

It was soon found that better results were obtained by partially hydrogenating the whole batch of oil to a desired melting point, rather than making mixtures as described above. Further, by controlling the conditions governing the hydrogenation process, such as temperature, pressure, etc., selective hydrogenation can be accomplished, giving products which are more suited for particular uses in baking. In rendering animal fats, there is very little that can be done toward changing the qualities of the resulting lard or oleo, but by selective hydrogenation, various types of shortening can be produced, some of which will cream better than others, some will be more suitable for home cooking, others for bakeries, etc. As a result of all this work, it is possible to produce vegetable shortenings from any one oil or mixture of oils without the use of stearine or any other added materials.

These processes of neutralization or refining, deodorization, and hydrogenation have been applied not only to cottonseed oil, but also to all other types of animal and vegetable oils, including marine animal and fish oils. The only limitation found so far is that it is not yet possible to deodorize fish oils satisfactorily, unless they have been previously hydrogenated. All other oils can be refined and deodorized satisfactorily in their normal state, and all oils can be hydrogenated satisfactorily, with previous or subsequent deodorization. Through these three developments, edible products can be produced not only from vegetable oils, but also from fish, and marine animals such as the whale and seal. It is now possible to change soft oils to harder oils and fats, suitable for many industrial purposes for which they were not available before.

The net results of these developments, which are wholly due to the pioneer work of chemists, have been to change the dietary of the whole civilized world, by adding vegetable shortening, nut margarines, etc., to the list of foods of mankind, and to increase tremendously the values of all kinds of fats and oils. This increase in use and value is felt not only among the farmers of this country, who are now obtaining $200,000,000 a year for their cottonseed alone to say nothing of the increased value of all other oil-bearing seeds, but also in all other parts of the

world even in the most remote places wherever these seeds and nuts are grown, and among the most primitive peoples. The change of the dietary is amply demonstrated by the amount of vegetable shortenings, nut margarines, etc., now used. It is further proved by the fact that vegetable shortenings are now frequently higher in price than similar fats of animal origin; whereas fifty years ago, there was no other use than soap making for cotton oil and other similar vegetable oils.

Contribution of the Chemist to the Electrical Industry

(*Continued from page 154*)

thoroughly inert atmosphere by the use of "getters," or chemical substances to remove harmful vapors and gases.

The efficiency of Edison's first lamp was 1.3 lumens per watt; that of the present-day 60 watt tungsten lamp, 12.5 lumens per watt. Before 1879, no homes were wired for electricity; now 70% in this country have this convenient method of lighting. Luckiesh says that if the unskilled laborer of 60 years ago had used as much light as is now used daily in the average American home, he would have had to work for $2^1/_2$ hours daily to pay his gas lighting bill alone, whereas now the same quantity of light may be obtained by only 10 minutes of his labor.

The economic savings produced by the efforts of chemists can be shown to be enormous, yet the intangible effect on our social structure is perhaps of greater importance. Working hand in hand with physics and engineering, it has made possible the organization of huge cooperative groups such as New York City, a three-dimensional community; the distribution of power to the home for labor-saving devices, and to the small rural industry; the provision to the individual of information and entertainment by radio; the almost instantaneous transmission of news around the globe. The stimulation of thought produced by increasing changes and an ever-widening outlook is, however, the most significant result. Who can tell what changes in political structure may not result from the ability of a leader to address the whole world as his audience, and from our knowledge of what is transpiring in remote sections of the earth in time to prevent or anticipate the consequences?

The Contribution of the Chemist to the Cosmetic Industry for the Advancement of Modern Civilization

By Florence E. Wall, F.A.I.C.

Consultant

ANY mention of cosmetic, beauty, and beautification in a scientific gathering frequently elicits a titter and a leer, with many lifted eyebrows; or perhaps a disdainful frown, with patronizing remarks about the vanity of the ladies and their nefarious ways with "paint and powder."

From several years' observation of these reactions, there is abundant evidence that such attitudes and expressions are due to: (1) ignorance of what is meant by a *cosmetic;* (2) the quaint notion that cosmetics are used only by women, (3) with only frivolous intent, or perhaps not respectable purposes. All of which is both sad and absurd.

Most scientific and professional people, when and if they can be made to think of cosmetics at all, have a mental picture of lurid lipstick, heavily beaded eyelashes—something very unpleasant. From its etymology, the word means something that adorns or beautifies; and my own definition of a cosmetic is "any substance, preparation, appliance, treatment, or operation, used in any way to effect any improvement in the appearance or attractiveness of any person." That is well calculated to catch everything, coming or going, because it includes: all preparations for skin, scalp, hair, hands, teeth; deodorants, mouth washes, anti-perspirants, depilatories; perfumes, soaps, aromatic materials; artificial hair, eyes, teeth, limbs; hairdressing, bathing, shaving, massage, plastic surgery, and embalming. So, considered in this broader aspect, who can say he knows or cares nothing about cosmetics? Or "wouldn't be caught dead using cosmetics?"

The phenomenal growth of the vast modern cosmetic industry can readily be credited to the work of chemists, but the benefits from their work, instead of being traced through any gradual development during the past three hundred years, can be more accurately confined within the past thirty.

The American colonies were settled during the period when cosmetics were not making any history at all. After five thousand years of association with medical arts and practices, the cosmetics had been

separated from them, and their lore was being rapidly scattered into the hands of a strange assortment of people. Alchemists, apothecaries, barbers, hairdressers, sorcerers, housewives, and ladies' maids—all took what they wanted from the old books; and the debacle was soon complete.

Whatever ideas on cosmetics were brought to the colonies naturally represented the state of available knowledge in the home country. Thus, in the English colonies along the Atlantic seaboard, anything that was needed had to be made by the overworked housewives or their maids, with the aid of one of those "Compleat Gentlewoman's Handbooks" with which England was flooded during the 17th and 18th centuries. The fine ladies in the Louisiana territory supported considerable traffic in all the elegancies of the French court; and those in the vice-regal provinces of Spain, to the south of us, had for a hundred years before John Winthrop's time been enjoying all the luxuries known in Spain, which during the 16th century, had the richest and most pampered court in all Europe.

The first industry in the English colonies which can be considered as allied to the cosmetic industry was soap making. Although this art was usually counted as one of the kitchen accomplishments of the ladies, its manufacture was soon centralized, and soap was in the markets as an article of barter even before 1635. One of my earliest recollections from primary school is that of hearing a very small, almost toothless boy stuttering from our baby history book that "B-Benjamin F-Franklin was the th-thon of a th-thoap maker." In our appreciation of our famous early citizen's later exploits as printer, author, and statesman, we often forget his humble origin; but there it was—in Josias Franklin, who had a soap and candle factory in the early days of the Massachusetts Bay Colony.

The progress of the soap industry in America has been so steady and productive of benefit that "the improvements in the social life of humanity resulting from the work of chemists in the soap industry" could well be the subject of a separate paper. Many of the now large and famous houses were established during the nineteenth century. Prolific research has been devoted to soaps, shampoos, and detergents of all kinds. Only two of the many who have made valuable contributions in recent years are Martin H. Ittner, and the late I. V. S. Stanislaus.

But in most other cosmetic products, things remained *in statu quo*. A factory for hair preparations and other odds and ends was established in Boston about 1706, of which the masterpiece seems to have been

plain, backwoods' bear's grease, peddled under a French name. Most preparations were still made in the home, or manufactured on a small scale by pharmacists.

During the 19th century there was a spurt of interest in all branches. A few physicians whose reputation was strong enough to stand the strain, recognizing the demand and wishing to provide their hopeful inquirers with good products, attempted to bring cosmetics for skin and hair up to date. But because almost nothing new had been developed, and because professional prejudice was so strong, their efforts had little permanent benefit. Most ethical physicians were still reluctant to investigate non-pathological conditions that came to their attention, much less do anything about them, or publish what they did.

It has always been admitted that cosmetics are merely "things for the thing signified"—beauty, and that most women have sacrificed no means to gain it. Products were few compared with the diversified "treatment lines" of the present day. The principal items were: two types of cream, cold cream and massage creams, of sorts; three shades of powder, white, pale rose, and deep rose—none of them a human shade; a few shades of rouge for cheeks and lips—all like war paint; a few dubious lotions; and hair dyes that were incredibly bad. Pages could be written about those cosmetics of the 19th century, and the hazards attendant on their use—especially those lead-loaded powders of the gas-light era, which were likely to turn a lady coal-black during an evening party!

The prejudice that was engendered against the use of cosmetics is readily understandable because the blatant, unnatural effects they produced almost guaranteed that even furtive use would be detected. With the Empress Eugenie gone, we in this country looked rather toward England than toward the more brilliant courts in Russia and Austria, for our ideas on etiquette; and as the Victorian era waxed Mid- and waned Late-, it came to be generally believed that one either used cosmetics and was "that kind of woman," or one did not, and was some other kind.

But soon after the turn of the century this blight was removed, chiefly due to the efforts of the self-appointed "beauty experts" who, having undertaken the manufacture of cosmetics on a large scale, began to invest some of their profits in research for better products. This marked the official entry of chemists into the cosmetic business. Some preliminary work was sufficient to show that much of the inherited recipes and notions on beautification were arrant nonsense. Out went the antiquated vegetables, the botanical simples, the medieval metallic

preparations! In came the new synthetic organic compounds, the active principles, the new coal-tar colors, powder bases, etc. Research in cosmetics finally came into its own as a laboratory quest for an answer to the question, "What does this type of skin need?" rather than a library quest for the answer to "What do they put into this kind of thing?"

About this same time, considerable popular interest in another branch of chemistry allied to cosmetics, was aroused by E. E. Slosson, in his fascinating chapter on perfumes in *Creative Chemistry*. The developments in other lines of products caused a marked increase in the manufacture of perfumes and essential oils, not only as luxurious adornments in themselves, but as scents or flavors for other products.

The cosmetic field has been peculiarly one in which credit must be given to individuals, especially to those who have persevered in the face of prejudice, opposition, and contempt, and helped to advance it. And the greatest personal influence in this latest period of development in the cosmetic industry is undeniably Professor Marston Taylor Bogert, F.A.I.C., of Columbia University. Through the generosity of the late Frederick E. Watermeyer, president of Fritzsche Brothers, a fellowship was established at Columbia, for research on essential oils. It has been continued by Mr. Frederick H. Fritz Leonhardt, his successor, and all the work has been done under Dr. Bogert's supervision.

So many notable contributions have been made in the field of perfumes and essential oils—would that Dr. Bogert himself were writing on the achievements in this alone! It is difficult to limit them, but some of the names that have been prominent in the industry are those of Benjamin T. Brooks, F.A.I.C., Ernest S. Guenther, E. H. Hamann, Harvey D. Seil, David Davidson, Victor G. Fourman, Clemens Kleber, and Francis Dodge. The late Frederick D. Power, of the old Bureau of Chemistry, and A. F. Sievers, of the Bureau of Plant Industry, have done notable work in the Government service, the latter in the production and development of exotic essential oil plants in this country. And we should not omit L. F. Henderson and E. C. Crocker, of the Arthur D. Little organization, who devised a most useful odor classification.

The development of synthetic aromatics opened up another whole field of research, in which only two of the noteworthy investigators were the late Alois von Isakovich, and Gustave Drobegg. The battle between natural *vs.* synthetic products, which has been waged in so many fields of organic chemistry, has had the result in cosmetics of bringing at least the semblance of once prohibited luxuries within the

means of many more thousands than could have enjoyed them otherwise.

Dr. Bogert's work on cosmetics has not been limited to the perfumes and essential oils. From forty years of broad experience in organic chemistry, he has been able to serve as the mentor of many students who have sought his inspiration and guidance in other branches of this work. In fact, we could call him "the mental grandfather" of many of the best modern cosmetics. Among his satellites was Ralph L. Evans, whose remarkable work on hair colorings, ten to fifteen years ago, constituted the greatest permanent contribution to this branch of cosmetics since the time of the Erdmanns in Germany. Dr. Evans now forms the center of his own little galaxy of former Columbia men, among them Everett G. McDonough. The latter, and many others from various schools—Edmond Fougera, Myra Ast Joseph, Dexter Neal, Paul Lauffer, Emil Klarmann, F.A.I.C., Warren Van Kirk, Frank Gephart—are responsible for many improvements in modern facial cosmetics and make-up. In other ways, too—in educational work, advertising, selling, plant production and development, efficiency service, and public relations—many other qualified chemists are contributing to the betterment and advancement of the cosmetic industry.

The beginnings of the increasing use of cosmetics are not so closely associated with the devastating results of the war or the "flaming youth" movement of the '20's, as the moralists seem to think. Just before the war (1911) some beautiful new products were introduced here from France—an entirely new range of tints in powders and rouges from which a selection could be made to blend most effectively with any complexion type. With such delicate artifices, women and girls could at last face stern husbands and fathers and agree sweetly with them that "there is nothing like a fresh, natural complexion." The revolution in thought infected women and girls of all ages; and many a known "ugly duckling" began to blossom mysteriously into "rather an attractive person after all," simply by accentuating her good points.

Prejudice soon began to dissipate like a mist before the sun. The constantly increasing demand for the better products, and the worthy efforts of the manufacturers to meet the demand soon set the industry on the way to its present high place on the nation's list. The fulminating sermons and incandescent editorials gradually ceased. More and more intelligent people have been coming to realize that the use of cosmetics is not a moral question, but merely a restorative art; and that men and women alike should be conceded the right to use any legitimate means to improve their appearance. Criticism should

more logically be directed now at the abuse of cosmetics, rather than at their use; but on this point it must be remembered that whereas composition can be controlled by science, application is controlled by the artistic skill and good sense of the user.

The recent depression has put the industry through a severe test, from which it seems to be emerging with credit; and to the stimuli of decreased prejudice and increased demand, must now be added the economic necessity for a good appearance in business. Regardless of how he may still protest his preference for beauty unadorned at home, practically every man, from the most chilly and conservative bank president down, prefers to have decorative women around his office. Business and professional women are learning that untidiness of hair and dress, and a pale, uninteresting face are no longer counted as the outward marks of their inner virtue and intellectual attainments. In these highly competitive days the pathetic job-seekers have already come to realize that, given two girls of equal ability, the one who gets the job nowadays is the girl who has bravely taken the depression on the chin and discreetly covered her bruises with well-chosen cosmetics before she calls for her interview. With excellent products now available in every chain store, the means of satisfaction are within reach of all.

Men, too, have been made acutely conscious of these needs, and in their rugged way, they are just as particular about their choice and use of their masculine cosmetics as any woman is about hers. The wholesome, psychological effect of a good appearance reacts with equal benefit in both sexes.

In their altruistic and psychological benefits alone, cosmetics have more than proved their social value within these past few trying years. Everything considered, it cannot be said that the enormous growth of the industry has been due entirely to human vanity. Ignored by most professional groups, the improvement you notice in whatever cosmetics you use is due largely to the work of chemists who, on either their own account, or that of far-sighted manufacturers who have employed them, have tapped that inner instinct for good grooming, and the ages-old desire to be just a little better looking—to make life just a little more pleasant which is deep in the heart of almost all civilized men and women, whether or not they will admit it. So it certainly seems that anything which in the main has produced such wide-spread beneficial effects, both subjectively and objectively, and is admittedly of such high aesthetic and commercial value should be given its due as a usefu contribution to humanity.

The Contribution of the Chemist to the Textile Industry for the Advancement of Modern Civilization

By P. J. Wood, F.A.I.C.

Mount Hope Finishing Company

FROM the dawn of civilization there has been ever present in the mind of man a yearning for something better.

In the beginning it was a question of maintaining life, and the bare necessities of food and shelter in their most primitive forms sufficed. With the development of community life, with its promise of greater security to the family and the individual, the mind of man was free to turn to matters of culture.

Development of better weapons for the chase resulted in more leisure time for the provider. The mind of man turned to the subjects of decoration—form and color. He began to express himself in variety of apparel and decoration of the home. That instinct observable in the sailor to tattoo his body in his spare moments is, undoubtedly, an example of that early human leaning toward art. Possibly the first articles of apparel were the skins of animals.

One can imagine those early inhabitants of the world wearing sheepskin garments which became matted and felted by the action of wear, the weather and infrequent washings. A warm day arrives and some ingenious individual conceives the idea of cutting out the skin from his sheepskin garment and, lo, the first woolen fabric is born into the world. The spider may have supplied the inspiration for the first weaver so far as we know.

The discovery of soap, one can imagine, may have been due to the spilling of fat from the kettle on to the wood ashes of some primitive camp fire; or maybe it was a concomitant of the invention of roast pig. (*Vide* Charles Lamb.)

With the advent of textiles arose the necessity of coloring the fabrics produced, and the first dyer came into being. It is not known whether the first colors used were mineral or vegetable. In any event one may suppose that the discovery of the method of coloring textiles was accidental. Staining of clothing during passage through a wild berry patch probably gave the first dyer the idea of purposely producing colored

effects. Those first efforts produced fugitive colors providing but temporary satisfaction.

Pursuing once again the flight of imagination we can visualize some wearer of those primitive dyed garments, discovering that some part of the coloring was faster to washing than the other. The first textile chemist set to work, with his questioning mind, to discover the metallic salt with which the garment had come in contact, and the art of dyeing had made another forward step.

Through the centuries, the textile chemist has battled with the problem of producing better fabrics, better fibers, better colors. In the earliest times the materials available were of natural origin, and very limited in number. It is surprising what varied effects and comparatively satisfactory results were obtained by those early dyers. Their methods were entirely empirical and the results of their experiments were closely guarded and held the property of relatively few people. Under these conditions, which obtained until barely a century ago, real progress was very slow.

In 1856 Perkin discovered *mauve*, the first synthetic organic dyestuff. The eyes of the scientific world became focused on the art of textile coloring, and since that time artificial colors have almost entirely superseded the natural dyestuffs formerly used by the old time dyer.

Within this period the textile chemist has been occupied with the problems of devising methods of application of the newer colors as they are produced, formulating methods of testing the fastness of these colors to various agencies. His efforts have raised the art of dyeing to the plane of an exact science. They have resulted in the cheapening of the processes of textile printing and dyeing, thus making available to more people those satisfactions provided by design and color.

Most worthy of note among the accomplishments of the textile chemist is the manufacture of artificial fibers dating from 1883 when Count Chardonnet produced the first threads of artificial silk and in 1891 established the first plant for the manufacture of what is now known as *rayon*. This invention has had a profound effect on the cotton and silk industries.

At about the same time Cross Bevan and Beadle discovered the secret of making regenerated cellulose, a method which formed the basis of the present-day manufacture of *viscose*. During the World War the Dreyfuss Brothers acetylated cellulose and produced the acetate fiber which they named *celanese*. The work of these textile chemists has resulted in the establishment of a gigantic industry which has spread to all quarters of the civilized world making work for hundreds of thousands.

Due to the work of the textile chemist faster colors are now the rule rather than the exception. The results of his labors have been faithfully recorded and accurately reported to the enrichment of scientific literature and for the benefit of future workers in this field. His work has been fostered and encouraged by the American Association of Textile Chemists and Colorists, The Society of Dyers and Colorists, the U. S. Institute for Textile Research, and The Textile Foundation. By their financial assistance and by their efforts in organizing a great body of volunteer workers, these organizations have made it possible to carry on research work of a practical and fundamental nature which is of inestimable value to the textile industry.

Both from the aesthetic and the economic point of view the textile chemist is serving mankind.

Contribution of the Chemist to the Rubber Industry

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that is, they are being used where their properties are better than those of natural rubber.

Rubber is resistant to the action of many chemicals, and this property is used to advantage to ship and store many acids, solutions of corrosive salts, etc., in tank cars, and tanks. These containers are of metal and lined with a rubber compound. The thin layer of rubber is attached to the steel by the use of special cements prepared by the action of certain chemicals on rubber, and thus the corrosion-resistance of the rubber is combined with the strength of the metal to make a structural unit of much value in industry.

Furthermore, rubber is being converted chemically not only into new compositions for special cements, but also into other chemical derivatives, such as resin-like materials which are mouldable and are useful in paints; chlorine derivatives which are of service as corrosion-resistant paints and in other cases as transparent waterproof film materials for packaging, etc.

Rubber is a unique substance. It has become part of our civilization. Suppose it was suddenly removed from our midst! What would people do without rubber bands, bathing caps, boots, shoes, heels, jar rings, hose, gaskets, tubing, gloves, sports goods, hospital supplies, toys, belting, stoppers, aprons, hot water bottles, tires and tubes?

The chemist has done much, and he will do more.

The Contribution of the Chemist to the Paint Industry

(*Continued from page 182*)

by the quick-drying feature of the paints of very recent years. Storage time has been decreased, and therefore the necessary storage space and expense; at the same time a faster turnover is possible, decreasing the necessary amount of invested capital and interest charges.

The householder, too, finds much of the former discomfort gone when floors, walls, and furniture require repainting, if he makes use of the newer quick-drying and hard-drying products. Floors may be trod upon and chairs sat upon, with impunity, not many hours after they have been coated. As a matter of fact, these products can be made to dry even faster than they do now. For example, road marking paints, of very obvious utility, are made to dry hard within a comparatively few minutes. But in the case of most other paints, especially those to be applied to vertical surfaces, any further reduction in drying time might have to be made at the sacrifice of ease of application or uniformity of finish. Paint has rightly been referred to as a compromise.

Because of the intense hiding which it is possible to obtain in modern paint, the amount of paint required for many types of work has been enormously reduced. This has led to a double economy, in the cost of the paint itself and in the cost of application.

Painting has become an excellent form of investment. It not only helps prevent property from deteriorating, but actually increases the value of a home or building to an extent far beyond the cost of the painting. During the recent years of depression, many a worried home-owner has found that a coat of paint was the "open-sesame" to a mortgagee's money-bags.

The effects of the paint chemist's activities are world-wide. His field of raw materials is constantly widening as he adapts to his uses new pigments, new oils, new resins, rubber, cement, casein, etc. His eyes are closed to nothing which may serve some special purpose. With each new development the market for some particular material widens. A waste product or a previously undeveloped crude finds a new use; the country's capital increases, as does employment in a new industry.

Of particular importance is the fact that the paint chemist has considered the consumer's viewpoint from all angles. Painting, thanks to the chemist, has changed from a moderately priced luxury to a low priced necessity. And the chemist, unwanted by the paint industry not so many years ago, is now indispensable to it. He has done a good job.

The Contribution of the Chemist to the Metal Industry for the Advancement of Modern Civilization

By Thomas A. Wright, F.A.I.C.

Technical Director, Lucius Pitkin, Inc.

THREE Hundred Years! An age of pioneering now drawing to a close so far as it dealt with the conquest of our own land. Pioneering that laid emphasis upon muscle and brawn, so far as the many were concerned, rather than upon vision and mental attributes. As pioneering followed exploration, so it was in turn followed by development. Proper development required metals, and proper metal required not only technical knowledge but also an appreciation of the economic and social forces of nature. In all this the chemist and metallurgist played no mean part.

Yet this conquest of land and of stream, of forest and of desert, of deep canyon and high mountain by our peoples would never have proceeded at the pace it did if it were not for leaders. The muckraker sees only a sordid greed, the poet only a high and noble purpose in that leadership. The truth as usual lies in between.

It is not strange, after all, that historians and romantic novelists alike have paid tribute almost entirely to those phases of that age that dealt with battles. Battles with a foe that was now human, now animal; or again, nature in one of its awe inspiring, querulous, or combative moods.

Yet energy and motion being so very typical of that age it is true, nevertheless, that hidden behind the glamour and the romance, the excitement and eagerness of the search for land and gold were those who, in their less spectacular fashion, supplied the needs of the industries, which in turn supplied and nourished the armies of occupation as well as the armies of advance. Among these, as intimated, were the professional or technical men.

Chemistry was not really articulate until comparatively recent times. Particularly was this the case with metallurgical chemists. Yet paralleling the history and growth of this nation, in breadth as well as rate, has been the use of metals. Of the group commonly considered as metals only ten were known before the eighteenth century, but between 1730 and 1830 thirty-two were discovered. Of the first ten,

seven were known to the ancients. Some were even then, and all are now inextricably woven into our social fabric and our personal lives and well-being. A safety pin meets us when we enter the world (sometimes a pointed contact) and a metal handle carries us out.

Gold, silver, iron, copper, mercury, lead, and tin were the seven, with the brass of the Bible ancient and honorable; eagerly sought and indispensable, every one used in or for war it is true, but every one of even greater moment as a servant of industry in times of peace.

Aside from their basic rôle as a constituent of animal and plant life and of the soil from which we spring, it is not as a pure element that metals have found their greatest uses for mankind. Rather has it been as alloys combined by men (chemists in outlook if not in fact) in the last third of the three hundred years of chemical progress that is being celebrated this year.

Unless it be in the field of preventive and, of course, curative medicine, possibly no one phase of the development of chemistry and of chemists has so vitally affected mankind as the art of alloying; an art that is now reaching for—and slowly but surely finding—firm foundations; an art that is now at last a science, and science is in the hands, and a tool of, the man.

It is the habit to speak of these times as The Machine Age. One may just as truly call this last hundred years at least The Alloy Age, for once energy ceased to be localized and motion called for faster and longer transportation, forces in man's nature may have been let loose so that the end is not yet, but certainly forces in man's products were, and those forces were studied. In many cases study led to control. Control led to further developments, each calling for still greater strength and resistance to fatigue, to wear, to corrosion, and to all the other specifications which metals can only or best meet.

Thus special steels—and in later years non-ferrous alloys—were developed, still further extending man's ability to transport and be transported. Man's vision grew less narrow. Thus copper became synonomous with communication by the tongue and ear; just as lead, tin, and antimony in type metal had represented communication by the eye.

Energy, too, must needs be conserved through the seasons when food is scarce. Tin as tin-plate became a symbol of the approach of civilization—or lack of it. The tin-can as a food container, whether it be pork and beans for an army in Cuba or France, gasoline or dog biscuits for Byrd at the South Pole, has been in the forefront of the pioneering of the last stages of this era. Its use has permitted the growth of the city

as we know it. With the great refrigerating warehouses with their miles of corrosion-resisting pipe it has changed the habits of whole peoples. The seasonal luxury of a century ago is the regular necessity of today.

Steel and copper together have welded a continent and, in making more uniform a people, have introduced this characteristic and suppressed or colored that one. Some may question that this steady approach to a common oneness is progress. Few will deny that the first step in understanding is to know one another.

Men who work with metals are like them in that they tend to be practical, but also in that persistence is one of their traits. The rôle of the metallurgist is then a quiet and generally unassuming one. Not for him is the newspaper headline for isolating a new vitamin, developing a new corrective medicine for some dread scourge of his fellow man, creating a new dye or subtle perfume for my lady. No, all the metallurgical chemist is called upon to do is to see that the engineer gets the material he specified (with the chemist's advice, it is hoped) for the country's railroads, its autos, its great power generators, telephone and telegraph lines, its radio, its movies, its process apparatus, its container for beverage and fruit, meat and vegetable, heavy chemical and cold cream, or its paints and collapsible tube, lithographers' plate and printers' type, the gold that goes into Uncle Sam's Treasury and the gold that stays there. It would be far simpler to mention the phases of civilized life in which metals have no part.

Progress? Social well-being of humanity? Art and culture? What not? Ask the biologist. Ask the food chemist. Ask the metallurgical chemist. All are close to life. Ask any chemist.

Imagine cleanliness and sanitation three hundred years ago. Visualize the improvement in the latter (and the former) without metals and the men who find them, win them, refine them, alloy them, color them, finish them, join them, form them, or analyze and evaluate them.

Metals are everywhere. They control in part our very life. They are of us and we of them.

Academic Contribution of the Chemist to the Dye Industry

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their activities during the formative period of the science of chemistry in America. Their success in developing a more general interest in chemistry in America was no small achievement, but the recognition of the scientific spirit in research in America was their great contribution.

Every nation participating in the World War has honored the rank and file of its enrolled armies by erecting a monument to its "Unknown Soldier." In our army of chemists there have been and are many who contributed to the wealth of knowledge which has made possible the remarkable development in this branch of chemistry in the United States.

The chemists, both teachers and investigators, whose efforts have been expended altruistically have on the whole received but little material recompense. They have had the joy of knowing that their contributions, direct and indirect, to the fund of human knowledge have benefited our nation. Even though the worth of the altruists in chemistry is all too little recognized in this material age, science is the richer because of their labors. The fund of scientific knowledge accumulated by them is their lasting monument.

Contribution of the Chemist to Heavy Chemicals

(*Continued from page 150*)

will come when the human effort in food production will be as small a factor as it is in manufacturing.

Chemists know that a great deal more remains to be done and that rapid advance can be made if research and technical enterprise are broadly and fully supported. They are making it their task to seek this support and they have a powerful argument in the present need for economic rehabilitation. In the face of this, it is strange that it should be so difficult to attract the attention of those on whom such action falls as a duty, or from those who only profess to be doing so much, especially from government agencies.

Much indispensable fundamental knowledge is lacking. Yet the government has actually reduced its appropriations and is neglecting a timely opportunity to establish essential data now, when so many trained and experienced engineers and chemists are out of employment.

The Contribution of the Chemist to the Food Industry for the Advancement of Modern Civilization

By Walter H. Eddy

Professor, Physiological Chemistry, Columbia University

THE PAST twenty-five years have seen a complete change in the merchandising methods for foods. Twenty-five years ago, taste, flavor, appearance, purity were the bases of appeal for the food seller. With phenomenal progress in the science of nutrition, the public has come to realize that health is dependent on food selection and diet. Result: every food vendor today tries by his labels and advertising copy to prove to you that if you buy and eat his product it will supply something that your body needs. He realizes that taste, appearance, and purity are still matters controlling repeat sales but he's gone to the health appeal to make you stop, look, and listen.

If you doubt this, run through the food advertisements in any nationally distributed magazine and read the copy. Here are just a few examples:

Buy milk for its calcium, proteins, vitamins.

Buy coffee for its freedom from rancid oils or caffeine.

Buy salt for its goiter preventing iodine.

Buy canned foods for their vitamins.

Buy oranges for their contribution to dental health and protection against acidosis.

Buy prunes because somebody has discovered a new laxative element therein.

There is no need to go on. Try and find a food today that fails to stress its nutritional contribution! Once, the function of the chemist in the food industry was very similar to that of the steel chemist: to devise new combinations and to control uniformity. For some years now that has been changed. The food chemist today is charged with exploration to measure and discover food values; to devise new methods to conserve these values and deliver them unimpaired to the consumer. Since the success of merchandising in a competitive market depends not so much today on the nature of the food as on its health-selling points, the chemist in food industry today occupies a position close to executives, sales managers, and advertising manager. Food industries had always to carry a chemist but today he's the mainspring of the works.

You all realize the phenomenal development of tomato juice as an available product almost over night. What part did the chemist play? First he showed that mere straining and sterilizing of the juice didn't deliver a satisfactory product. He showed that the vitamin A was in the pulp and not in the filtered juice and he had to find a way to homogenize pulp and juice to make the former stay suspended. But this wasn't all. His tests showed that if it was to compete with orange juice as an antiscorbutic he'd have to get rid of oxidation in preparation. He rebuilt sieving machinery, introduced vacuum handling and other devices to accomplish this end. All this to provide something that was not simply palatable but something that brought to you unimpaired the nutrition values students said you should get from tomatoes. And after this was accomplished, he kept on and devised new chemical tests to measure these health values so that every lot leaving the plant could be guaranteed as to vitamin values.

The nutrition students attacked and broke down the theory that milk is a complete food. It didn't give baby his vitamin B and C. It lacked D. It was shy in iron. Milk supplements began to appear to meet these defects. Today they're legion. All are the creation of the chemist. What are your *Ovaltines*, *Cocomalts*, *Maltovims*, *Runkomalts*, etc., but creations to increase milk use and to supplement its deficiencies as a child builder? Why were strained baby foods created and what are their selling points? Who invented irradiation and developed irradiated milks, oat meal or fortified breads, and ice creams so that these old staples could put forth a new set of sales appeals? Certainly the chemist did.

Take table salt. Who would have dreamed of a field for the chemist in this industry except as a control official in purity? But today we get it iodized. Physiologists and chemists hit on it as an ideal carrier of iodine to those in the goiter belts. Iodized salt changed the salt industry's objectives and the chemists made it.

Some years ago the nutritionists began to accuse us of eating too soft diets. Attributed our digestive disturbance to lack of roughage. Food industry took a by-product of flour making, bran, and made a medical food out of it. But the development didn't stop there. The physiologists said scratchy fiber irritates. Soften your fiber! The chemist stepped in. He developed new forms of absorbent non-scratching fiber. A rice flake product depends for its chief claim today on a new form of cellulose thus developed. The chemist studied the action of fiber and found that gastro-intestinal regulation wasn't due entirely to the fiber but in part

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The Province of the Paint Chemist

By Maximilian Toch, F.A.I.C.

PRIOR to 1906 there was no book published on the chemistry of paints. To be sure, chemists knew the composition of white lead, zinc oxide, chrome yellow and such other simple chemical compounds. I never found anybody who could give me a real definition of Indian Red, Tuscan Red, the Siennas and the Umbers, and in order that paint manufacturers might know more definitely the composition of the material they were dealing with, I wrote the first book on the Chemistry of Paints, about 30 years ago. Since then in all countries many more competent chemists have added to the subject.

So little was known concerning the purity of some of the raw materials that when I made my first investigation of turpentine and personally visited many stills in the South, I found that when nine barrels of gum thus, which is the sap of the pine tree in its raw state, were put in a still in order to obtain rosin and turpentine, a barrel of kerosene was usually added for the reason that it made it "distill better."

It was about that time that some of us got together and established chemical methods and a specification for turpentine, which holds good to this day. I have always contended that specifications are a bar to progress. You can write a specification for copper, zinc, steel, white lead, and materials that have a definite elementary composition but you cannot write a specification for a piano or a plate of chicken soup—and by the same token, if you take one-half dozen raw materials and three or four liquids and compound them into a mixed paint, no chemist can definitely describe these in a specification because the oils, dryers, and the pigments themselves undergo changes which make them different than they were originally.

Furthermore, in paint chemistry it is performance that counts. I think our present-day spar varnish specifications are a joke and include everything except the kitchen stove—nor can there be in the specifications a reasonable guarantee that the material will serve its purpose as well in New York as it should in Key West after one year. It is true that we have weatherometers, ultra-violet, infra-red, salt spray, and many other appliances which are supposed to tell us in 21 days what the paint will do in 21 months but I have never seen a laboratory result that equalled a field result. As evidence of this, paint will last for

two years in England and still retain its gloss and will not last six months in New York State. So it behooves the chemist, when he makes an analysis, not to be a palm reader or fortune teller and give an opinion as to whether a paint is going to be good or not.

I have employed many chemists in my time and have some slight reputation as a paint chemist. I will not allow any of my men to give me an opinion as to whether a paint is going to wear or not. Since the advent of Bakelite and similar materials, no analysis means anything when these complex synthetics are added in part to an otherwise good mixture. It is true that exposure panels on a roof at a given angle give some indication as to the wearing quality of paint and varnish. All you have to do is look at the North side of any tank or gas holder and after two years you probably will find that the North side is in perfect condition and the South side has gone to pieces.

There is so much difference between theory and practice that I am reminded of the statement of the great vant Hoff, that if you take a chicken, cut it up and add suitable condiments and make a chicken stew, no skill, knowledge or science can ever reverse the reaction and give you back the condiments and the raw chicken. The same is true of mixed paint and varnish and the paint chemist has much work to do on account of the tremendous advance that has been made in an almost unknown field.

Contribution of the Chemist to the Varnish Industry

(*Continued from page 168*)

could he suddenly re-awaken, would be lost in a multitude of modern chemical pigments. Likewise in plasticizers, chemical driers, new esters and ethers of cellulose, flatting and dispersing agents, there has been a tremendous development even during the last ten years.

Perhaps no other industry has experienced so complete a change to chemical products placed at its disposal. And the directing force of this awakened industry, evaluating his raw materials, controlling his formulations and procedures, developing new products and markets, is the chemist. It is to his alertness and vision that the executive has turned. In this position he faces broad responsibilities but, with these responsibilities, larger fields of endeavor and greater opportunities. In changing varnish manufacture to one of our greatest chemical industries he has awakened new recognition for the chemist.

Contribution of the Chemist to the Food Industry

(*Continued from page 202*)

to the vitamin B in bran. *Embos* and *Bemaxes* appeared on the market and vitamin B reinforced cereals. And now certain older cereal producers have had new assays of their product made to permit them to climb onto the vitamin B selling wagon.

These examples could be expanded almost indefinitely but perhaps they suffice to emphasize how integral a part of food industry today is the chemist and how his rôle has enlarged from a manipulator of quantitative measurement tools to an evaluator of food values and the reliance of the sales and advertising departments.

I think you'll grant this new field of opportunity for the chemist and the dependence of the food industry of the future on him. But if you do, you will also recognize that the food chemist of that future will have to have a different training from that given in the past. Food chemistry has taken a physiological slant. Today's food chemist must know his vitamins, his physiology, as well as his quantitative analysis.

In 1906, the Pure Food Law created jobs for the chemist in food industry as a guardian of purity, an assayist to avoid adulteration, a synthesist to devise harmless dyes for use in foods. As I write this, there is before the U. S. Senate a new Food and Drug Law. If it is enacted, every claim made for a product in advertising will be subject to analysis for factuality and misstatements penalizable by fine or imprisonment. Who is going to judge of this factuality? Who is going to be the industry's defense witness to support the claims made or to protect the manufacturer from seizures and prosecution? The new type food chemist. His employer's legal department is going to rely on this individual to support defense actions. The food chemist's job is going to enlarge still further. He's going to become still more of a factor in the merchandising of foods than he is today.

There's hardly any industry today to whose development the chemist cannot point with pride and say, "I made this and that possible," but I know of no industry in which there is higher opportunity for the younger group today than in the food industry. It still needs skilled analysts with the abilities developed only by years of practice but it also needs today those skilled in fields that the old analysts never studied. Food as a means to health is today's product of a new school of chemical training. The Industry is going places and doing things and it offers wonderful positions to the properly trained crop of new chemists.

THE AMERICAN INSTITUTE OF CHEMISTS

Objectives of the American Institute of Chemists

1. To provide and enforce a code of principles of professional conduct which merits public esteem and justifies confidence in the integrity of the chemist;

2. To establish and maintain a standard of proficiency of such excellence as to insure competent and efficient service;

3. To secure an adequate basic training for the profession and admit to fellowship in the Institute only those of proved education, experience, competency, and character;

4. To strive to enhance the prestige and distinction of the profession and to extend its influence and usefulness;

5. To establish and maintain a register of membership in which there shall be a complete record of the training, experience, and fitness for service of each member;

6. To seek to improve the economic status of the profession by cooperating with employers to secure a satisfactory appreciation and evaluation of the services of the chemist;

7. To provide a means for the appropriate recognition of distinguished service to the profession;

8. To cooperate with all agencies serving chemistry to make the profession of chemistry a powerful factor in the advancement of intellectual and material progress in the United States of America, to the end that this nation shall assume its rightful place as a leader among the nations of the world in scientific thought and accomplishment;

9. To lend support to the work of the chemical societies in the education of the public to a better appreciation of the contribution of the chemist to world progress;

10. To render such other services to the profession as developments shall warrant and The American Institute of Chemists shall approve.

Code of Ethics

The profession of chemistry has become an increasingly important factor in the progress of civilization, and in the welfare of the community. Chemists are entitled to the position and authority which will enable them to discharge their responsibilities properly and to render effective service to humanity. In order that the honor and dignity of the profession be advanced and maintained, The American Institute of Chemists has prepared the following code to define the rules of professional conduct and ethics, binding on its members.

1. Every individual, on entering the profession of chemistry and thereby becoming entitled to full professional fellowship, incurs an obligation to advance the science and art of chemistry, to guard and uphold its high standard of honor, and to conform to the principles of professional conduct.

2. It is the duty of a chemist to bear his part in sustaining the laws, institutions, and burdens of his community.

3. The chemist shall not knowingly engage in illegal work or cooperate with those who are so engaged.

4. A chemist shall carry on his professional work and act in a strict spirit of fairness to employers, contractors, and clients, and in a spirit of personal helpfulness and fraternity toward other members of the chemical profession.

5. He shall refrain from associating with or allowing the use of his name by any enterprise of questionable character.

6. Advertising matter containing his name shall be dignified in tone and characterized by due scientific restraint. Such advertising matter shall not contain any statements which may tend to bring himself or his profession into disrepute. Equivocal or false statements or statements which are liable to mislead shall not be permitted. The use of personal photographs or self-laudatory statements is condemned. If a title is used, it must be definitely characterized.

7. He shall cooperate in upbuilding the profession by exchanging general information and experience with his fellow chemists, and by contributing to the work of technical societies and the technical press, where such information does not conflict with the interests of his client or employer. It is very desirable that the first publication regarding inventions or other scientific advances be made through the technical societies and technical publications and not through the public press. Care shall be taken that credit for technical work be attributed as far as possible to the real authors of the work.

8. If, in his opinion, work requested of him by clients or employers seems to present improbability of successful results, he shall so advise before undertaking the work.

9. He shall be conservative in all estimates, reports, testimony, etc., and especially so if these are in connection with the promotion of a business enterprise.

10. He shall not accept compensation, financial or otherwise, from more than one interested party without the consent of all parties concerned, and shall not accept commissions from outside parties on sales to his client or employer without their knowledge. He is, however, in no way debarred from accepting employment from more than one employer where there is no conflict of interests.

11. He shall not use any unfair, improper, or questionable methods of securing professional work or advancement, and shall decline to pay or accept commissions for securing such work.

12. He may use all honorable means

in competition to secure professional employment but shall not, by unfair means, injure directly or indirectly the professional reputation, prospects, or business of a fellow chemist; and shall not attempt to supplant a fellow chemist after definite steps have been taken toward the latter's employment.

13. He shall not knowingly accept employment by a client or employer as substitute while the claim for compensation or damage, or both, of a fellow chemist previously employed by the same client or employer and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the chemist previously employed has neglected to press his claim legally.

14. He shall be diligent in exposing and opposing such errors and frauds as his special knowledge enables him to recognize.

15. Any infractions of these principles of professional conduct, coming to his attention, shall be reported to the Ethics Committee of The American Institute of Chemists.

16. He shall not attempt to compete with a fellow chemist on the basis of professional charges, by reducing his usual charges in order to underbid, after being informed of the charges named by the competitor.

17. He shall not accept any engagement to review the professional work (except journal articles and similar scientific publications, and in litigation) of a fellow chemist without the knowledge of such chemist, or unless the connection of such chemist with the work has been terminated.

18. When undertaking work for a client or employer, he should enter into an agreement regarding the ownership of any and all data, plans, improvements, patents, designs, or other records which he may develop or discover while in the employ of such a client or employer. This agreement should include a restriction of the use of reports for advertising purposes. In the absence of a written understanding the following principles are held to apply:

(*a*) If a chemist uses information obtainable only from his client or employer which is not common knowledge or public property, any results in the form of designs, plans, inventions, processes, etc., shall be regarded as the property of the employer.

(*b*) If a chemist uses his own knowledge or information or data which by prior publication or otherwise are public property, then the results in the form of designs, plans, inventions, processes, etc., remain the property of the chemist, and the client or employer is entitled to their use only in the case for which the chemist was retained.

(*c*) All work and results accomplished by the chemist outside of the field for which he was employed or retained are the property of the chemist.

(*d*) Special data or information obtained by a chemist from his client or employer or which he creates as a result of such information, are to be considered confidential, and while it is ethical to use such data or information in his practice as forming part of his professional experience, its publication without permission is improper.

(*e*) He shall not suppress information or unduly accentuate statements in reports for the purpose of making gain or profit to himself or others.

19. He shall as far as possible in consulting work fix fees at a point high enough to warrant complete and adequate service. Unreasonably low charges for professional work tend toward inferior and unreliable work. In fixing fees it is proper for him to consider:

(*a*) The time and labor involved, the novelty and difficulty of the matter,

and the experience and skill necessary.

(*b*) Whether the employment precludes other employment in similar lines or will involve the loss of other business while engaging in the particular work.

(*c*) Customary charges of chemists for similar services.

(*d*) The magnitude of the matter involved, and the benefits resulting to the client from the services.

(*e*) The character of the employment, whether casual or for an established and constant client.

20. While it is desirable that chemists engaged in teaching and research should be permitted to use their special knowledge and skill in direct service to individual clients, it is prejudicial to the welfare of the profession for such services to be rendered at rates which ignore ordinary costs of equipment, supplies, and overhead expenses.

21. Having established a fair fee and billed same to a client, he should oppose any effort of a client to have such fee reduced without real and sufficient cause. Wherever compatible with self-respect and the right to receive a reasonable recompense for services rendered, controversies with clients regarding compensation are to be avoided. There should, however, be no hesitation to apply to the courts for redress to prevent injustice, imposition, or fraud.

Qualifications for Membership in The American Institute of Chemists

The membership of the Institute consists of Honorary Members, Fellows, Associates, Juniors, and Student Members. All members are citizens of the United States of America.

Student Members are those who have attained the fourth year in chemistry or chemical engineering in an educational institution of recognized standing.

Juniors are those who have received the bachelor's degree, or its equivalent, on completion of four years in chemistry or chemical engineering in an educational institution of recognized standing.

Associates are those who have had a minimum of six years of collegiate and postgraduate work in chemistry or chemical engineering, at least two years of which training must be of an advanced nature, or who can demonstrate to the satisfaction of the Council that they have the equivalent of this educational training.

Fellows are those who have the qualifications of Associates and an additional five years of experience and responsibility in the practice of the profession, except that those who received their academic training prior to 1926 may substitute two years of professional experience for the two years of graduate study.